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Cemented Carbide Cutting Tools—I

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Tool design, as used for high-speed steel, will not do if best results are to be obtained from tungsten carbide. Important departures in practice are essential, and these are explained in a paper to be presented in Chicago during the week of June 26 under the auspices of the A.S.M.E. Metal Cutting Research Committee. So clear a contrast is made between the right and wrong application of cutting carbides that we have abstracted the first half of the paper below. The second half will appear in our next number

STRANGE though it may seem, the cemented carbides were developed through a study of failures. Successes take care of themselves; critical analysis of failures converts them into successes.

During the development period, it was found that, in general, a cemented carbide tool might fail because of one or more of the following:

1. The tip separates from the shank.
2. The clearance is destroyed by abrasive wear.
3. Spalling, chipping, crumbling or flaking of the cutting edge occurs.
4. The tip is softened and mushroomed by the combined influence of heat and pressure.
5. Cracks develop in the tip which either score the work or cause a fracture.
6. A chip cavity develops on the lip surface which may cause a section of the nose to shear off or which, in any event, requires the removal of considerable material to regrind the tool.
7. Pits develop in the lip surface as a result of transient built-up cutting edges incident to intermittent operation or because of surface fatigue.
8. The outer ragged chip edge grooves the lip cutting surface, and the shoulder at the depth of cut on the work produces a corresponding flank groove. These grooves, like the chip cavity, necessitate grinding away large quantities of the carbide to restore a keen cutting edge.

Each particular tip and shank size, clearance and rake combination with respect to the work contemplated possesses a certain critical or ultimate value of "failure resistance." Only when these critical safety factors are exceeded does tool failure occur.

Each successful application of carbide has resulted from careful planning to avoid the occurrence of any of these causes of failure. Almost all of the above types of failure have been encountered in developing cemented carbides for metal cutting tools. Each failure has been closely scrutinized, and effective steps have been taken to improve the product and its method of application.

Moissan first produced the intermetallic compound tungsten carbide by melting tungsten in the presence of carbon in his electric arc furnace. He noted that the product was extremely hard but porous and glass-brittle.

Heinrich Baumhauer, seeking a drawing die material which would serve as a substitute for the costly diamond, hit upon the idea of soaking up molten iron in the pores of the "gassy" melted and cast tungsten carbide. This material was used at the Osram Lamp Works for drawing tungsten filaments for electric bulbs.

Schroter, Strauss and their associates developed the idea of compacting under hydraulic pressure a comminuted mixture of powdered cobalt and tungsten carbide and sintering the briquet in a reducing atmosphere at a temperature far below that necessary for fusion of the tungsten carbide.

It was but a short step then to find that the strength and hardness of cemented tungsten carbide could be varied at will, within limits, by merely changing the binder content, the particle size, the sintering temperature and other determining variables.

Cemented tungsten carbide is today the unchallenged peer of all cutting tool media for machining cast iron and all non-ferrous and non-metallic materials. It does not, however, successfully machine all types of steel. The lip sur-

face quickly develops a deep chip cavity, and the cutting operation is accompanied by the generation of intense heat at elevated cutting speeds.

The addition of tantalum carbide in quantities up to that amount, which can be retained in solid solution in the metallic binder alloy of normal tungsten carbide, has been found to delay the formation of a chip cavity and to exercise a definite cooling influence. Unfortunately, tantalum carbide is not as strong as the truly metallic tungsten carbide. In those cases, where it is desirable to use a type of cemented carbide in which the major portion of hard carbide is that of tantalum, provision for this relative weakness must be made by using a binder constituent other than cobalt, which is at once tough enough and yet hard enough to withstand the heavy chip pressures incident to steel cutting without breaking in the one case or mushrooming in the other.

The class of work which is being done in the high production industries as typified by the automotive factories does not involve heavy cuts or coarse feeds. Upset forgings and modern castings do not as a rule necessitate the removal of more than $\frac{1}{8}$ to $\frac{1}{4}$ in. stock. For these semi-finishing and finishing cuts a new grade of cemented carbide is being developed. It has been found that the addition of relatively small quantities of titanium carbide to tungsten-tantalum cemented carbides or to cemented tungsten carbides exerts a most profound influence upon the hardness and consequently the abrasion resistance of these materials.

Certain Precautions Essential

Metallurgists and engineers have found that certain definite design precautions must be observed in producing satisfactory castings and formed steel parts or tools which are to be hardened and subjected to loads or stresses in service. An excellent discussion on this subject is included in the National Metals Handbook, in which the precautions necessary to the successful handling of tools made of high-speed steel are noted. Sharp corners, abruptly changing sections, stress raisers, such as splined or threaded sections, must be as studiously avoided in designing cemented carbide tools as in the case of high-speed steels and other metals fabricated or cast into usable shapes. Tool design is a part of the necessary planning which must precede the undertaking of any successful project.

We have listed the causes which might bring about the failure of a carbide tool. In order to avoid the effects of these causes, we must resort to better methods of tool design and technique of application than was necessary in the case of previous cutting materials.

The unique properties and latent possibilities of carbide tools justify in full measure the extra care which their successful use requires. Carbide tools will not work well unless care is observed, and if great care is taken, the results improve in proportion.

It has been truly stated by many writers on this subject that the introduction of cemented carbides has breathed new hope, and new life into the entire metal-cutting industry. The advent of carbides has provoked more careful thought and more searching after truth into the metal-cutting art than any other tool material yet offered.

Tool Design Factors

The principal factors governing tool design are:

1. Properties of the tool material,
2. Characteristics of the material to be machined,
3. Particular machining operation,
4. Condition and characteristics of the machine tool,
5. Required production rate, finish, accuracy and cost.

The properties of cemented carbides and their method of manufacture have been widely publicized and should be well known. Resort is made to cemented carbides usually to provide a cutting edge which will stand up for longer periods or remove metal faster than other cutting tool materials. The ability of carbides to withstand abrasive wear is closely associated with their great hardness especially at elevated temperatures. To expect great toughness associated with hardness of this magnitude is, of course, asking the impossible. Tool design and application must therefore be undertaken with the relatively low transverse strength and ductility of cemented carbides clearly in mind.

When planning an application of cemented carbides, it is imperative to learn as much as is possible about the characteristics of the material to be cut. It is true that cemented carbides will machine almost any material in almost any conceivable physical condition. This fact should not, however, blind us to the possibility of greatly improving carbide tool performance by learning and, if need be, changing the composition or condition of the work-piece in order to realize fully the lowered tool costs which are possible with these tools.

Before carbide tools are put to work, the chemical analysis, Brinell hardness number, tensile strength and previous heat-treatment, if any, of the work-piece should be definitely known.

If the material to be cut is a carbon steel, an effort should be made to obtain a spheroidized structure for the reason that with the major portion of the carbon out of solution in the form of rounded pearlitic globules, the abrasive action on the cutting edge and lip surface will be at a minimum.

Cemented carbides will readily cut the intensely hard scale and embedded sand on the skin of iron castings, and carbides will also cut white or chilled iron and unannealed iron. Simultaneous graphitization, hardening of the matrix and elimination of white, easily chipped edges through the use of nickel or other agents do, however, greatly prolong the life of carbide tools and thereby make even more interesting the savings in tool and machining costs. The annealing of castings such as pistons, cylinder blocks, machine beds and motor frames is also desirable.

The machining operation and the machine tool to be used are naturally closely related. The type of operation and the condition or characteristics of the machine tool will largely dictate the type or grade of carbide which is to be used and the cutting conditions such as cut, feed and speed. The required production rate, finish, accuracy limits and cost are all closely interdependent and are consequent to all of the steps taken in the design and plan of application of the tooling.

The component parts of tool design meriting individual consideration are:

1. Method of attaching the tip to the shank,
2. Tip and shank size,
3. Cutting edge contour,
4. Tip and shank shape,
5. Preparation of the cutting edge,
6. Tool angles,
7. Tool setting,
8. Tool block or holder and the work fixtures,
9. Selection of proper speeds, feeds and cuts,
10. Selection of a cutting fluid.

Method of Attaching the Tip to the Shank

The cemented carbide type of tool is composite in form; a small hard metal tip forms the cutting edge, and a steel shank provides the necessary support or holder. The method of securing the tip to the shank must hold the tip firmly, resisting both the forces and the temperatures encountered in metal cutting, and yet the tip must not be subjected to excessive tensile stresses arising out of the brazing or welding method.

The various compositions, which are commonly employed in welding high-speed steel tips to carbon or alloy steel shanks, were tried in the early welding

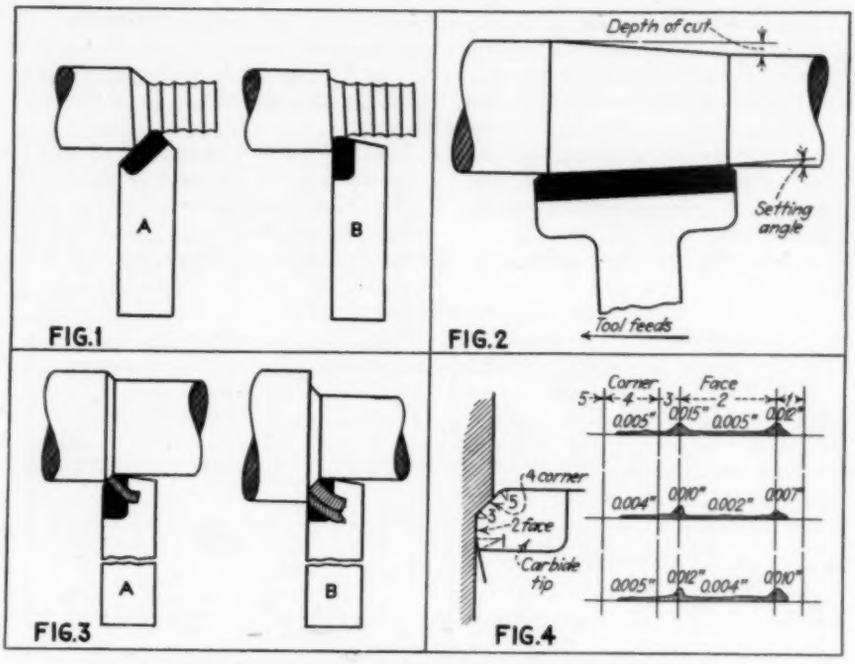

Fig. 1—Concentration of the chip pressure is avoided by the design at *A*. Fig. 2—For roll turning, a wide tool set at a slight angle has proved effective. Fig. 3—A 45-deg. cutting edge is satisfactory for finishing cuts but should be long enough to take the full depth as at *A*. Fig. 4—Measured wear on milling cutter teeth, selected at random, is greatest at abrupt changes in contour

experiments with carbide tools. Because of the greatly differing coefficients of thermal expansion of cemented tungsten carbide and steel used for shanks and the rigidity of a steel weld, this method was quite unsatisfactory. On cooling from the high welding temperature, tensile stresses were set up in the tip which caused cracks.

Today pure copper is almost universally used for securing cemented carbide tips to shanks. The copper is tough but ductile, and although it holds the tips firmly, it has sufficient "give" to protect the tip from the contraction forces produced on cooling from the brazing temperature (2050 deg. F.). The moderately high melting point of copper also tends to prevent the braze from squeezing out under the heavy cutting pressures and high temperatures incident to roughing work.

Copper brazing is normally conducted in an electrically heated hydrogen atmosphere furnace of the type used in the manufacture of cemented carbides. The tip is hand ground to a neat fit in the milled recess of the shank. Both shanks and tips are thoroughly cleaned by immersion in hot sodium hydroxide solution and then rinsed in clean water and dried. The shank recess is lightly sprinkled with borax or other flux, and a small amount of 0.003 to 0.005 in. copper foil is placed beneath the tip. The tip is wired in place with nichrome wire and covered with more flux and more copper foil. The tool is then pushed into the heating zone, and when the copper is observed to flow out from under the tip, the tool is pushed back into a water-jacketed cooling chamber where it cools in the same hydrogen atmosphere. A remarkably clean, sound braze is obtained, and the shank comes from the furnace as free from scale as it entered.

Tips may be brazed in a gas muffle with silver solder, brass or bronze, or with an open torch, provided that a strongly reducing flame is maintained and cleanliness is observed.

Tip and Shank Size

Both tip and shank should be as large as possible, commensurate with permissible first cost. The tip should be as thick but no longer than necessary. The shank should be as deep as the tool post or block opening or other limiting factors will permit. The shank should be at least 1½ times as deep as the shank of the high-speed or other steel tool which the carbide tool replaces. It is false economy to decrease the thickness of tip and depth of shank. The initial cost may be low, but frequent tool replacement or even breakage may result. These principles are, of course, subject to modification for finishing tools and tools such as reamers, counterbores and inserted milling cutter blades which are not ordinarily subjected to heavy loads in service.

Cutting Edge Contour

When cutting a ductile material, such as steel, the cutting edge should be chosen which will give the least amount of chip distortion. Energy expended in unnecessary chip deformation is surely wasted, and frequently it needlessly imposes excessive chip loads on the cutting tool.

The nose radius for light cuts should be as small as practicable, and wherever possible, the angle which the cutting edge makes with the work should be less than 90 deg. In Fig. 1, it is obvious that, while both tools may take the same depth of cut and feed per revolution and operate under the same cutting speed, the tool shown at *A* will be the more durable, since each portion of its cutting edge has less to do than corresponding portions of the cutting edge of tool *B*. This is especially important in cutting a hard, abrasive material which is decidedly destructive of the cutting edge such as chilled rolls.

In roll cutting, it is usual to employ a tool with a straight cutting edge, frequently six or more inches in length, which is fed by hand straight in to the desired depth. This is done at adjacent portions on the body of the roll until the entire length is bodied-off. The new roll turning lathes are equipped to feed such tools laterally or parallel to the axis of the work as in an ordinary engine lathe. In this case, as shown in Fig. 2, the tool is set at a slight angle which produces just the desired depth of cut in little less than the length of the cutting edge.

Wear Greatest at Corners

Conventional reamer and face milling cutter design teaches us that, for certain types of light finish cuts, the cutting edge is best chamfered at 45 deg. as shown in Fig. 3 at *A*. Care should be taken, however, to insure that the extent of the chamfer will accommodate the full depth of cut or the badly deformed type of chip shown at *B* will result. The corners should be rounded slightly or just broken as shown because experience teaches that wear will be most pronounced where the cutting edge contour changes direction abruptly. This point is well emphasized in Fig. 4, which shows the actual measured distribution of wear on the flank of an inserted milling cutter blade after face milling gray cast iron to a point arbitrarily selected as corresponding to the amount of wear permissible before regrinding.

For roughing cuts, the familiar Taylor round nose accomplishes somewhat the same purpose as the tool shown in Fig. 1 at *A*, since the chip is spread over a greater length of cutting than in the case of a straight 90 deg. setting angle bar

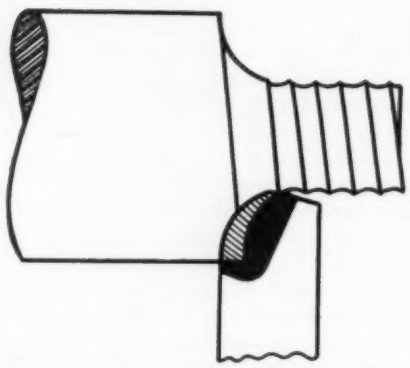

Fig. 5—Variation of chip thickness produced by round-nose tools tends to prevent chatter

turning or knife tool. The round-nose tool also tends to prevent chatter for the reason that the chip thickness is variable as shown in Fig. 5.

Tip and Shank Shape

The shape of the tip must be selected after a proper balance has been struck among several factors. The tip should have a form such that, after the last grind, no carbide is wasted. Another factor, which must be kept firmly in mind, is that, in our efforts to tip a tool with the carbide most economically shaped and located, we do not thereby specify a tool which will involve serious manufacturing difficulties on the part of the supplier.

The tip must be shaped and located in the shank recess, which receives it, to provide adequate support to withstand the forces developed in cutting. This means that the tip must have a broad, smooth base on which to rest, that there must be sufficient shank metal beneath and beside the tip to absorb the tangential and feeding pressure without deflection and that the bulk of the forces to which the tip is subjected must be transmitted to the steel shank.

Fig. 6 shows a few selected examples of correct and incorrect designs. At *A* is shown a circular form tool, which is unsatisfactory, because, as it is reground, the tip will become progressively thinner at the cutting end while maintaining most of its original thickness at the inner end. This is a complication that would not occur in the case of a homogeneous cutter made in its entirety of one material such as high-speed steel. The design shown at *B* has two striking advantages. The formed blank is left solid except for the milled recess for the tip and the saw cut shown. The tip is brazed in place—the idea of the saw cut being to break up any possible closed stress circles or hoop tension resulting from the brazing operation. The carbide tip being well supported on both sides by the steel shank permits rapid grinding to the desired form with no chance of chipping the edge. The tool is then gashed out as shown in dotted lines. As this form tool is successively reground, the tip thickness at the cutting point is always thicker or as thick as that at the inner end, and almost the last gram of carbide can be utilized in cutting.

These remarks, of course, only apply to those tools on which it is necessary that the cutting point be maintained at a constant distance below center. This distance fixes the clearance under the cutting edge. Circular forming tools for brass and other soft metals may be safely made to the design shown at *A*. Successive regrinds parallel to the original face will increase the below center distance and increase the clearance, which, however, makes little difference inasmuch as the tool pressure set up in machining brass and other soft metals is relatively low.

At *C* is shown a flat forming tool for brass journals which repeatedly cracked at the point indicated despite painstaking precautions. At *D* the tool is shown as successfully re-designed. This example shows clearly that abruptly changing sections are to be carefully avoided. As will appear repeatedly throughout the consideration of carbide tool design, the widely differing coefficients of thermal expansion of carbide and steel used for shanks impose definite limitations on tip and shank shapes and proportions. At the temperature, at which the brazing material freezes (1981 deg. F. for copper), the steel shank is still quite distended. Once the braze becomes solid, the further contraction of the steel shank on cooling can take place only at the expense of setting up stresses either in the carbide or in the braze itself.

Tips which extend to within $\frac{1}{16}$ to $\frac{1}{8}$ in. of the edge of the tool, as shown at *E*, Fig. 6, are to be avoided as the thin section of steel will warp during cooling from the brazing temperature and will pull away from the tip, giving rise to a poor braze or even a cracked tip. Where conditions, such as maximum, cutting edge length and limited space in tool setups or holders, seem to demand such a thin section for backing or shank support, it is far better to extend the tip entirely across the shank. If positive resistance to movement, resulting from side thrust, seems necessary, it is well to use a half round or bead key as shown at *F*. This form of tool is exceptionally strong and has fully proved its worth in actual practice. The dotted line shows that this method of anchoring a tip can be applied to round as well as square nosed tools.

Another vitally important consideration is the shape of the milled recess in the shank which receives the tip. For tools having steep side rakes, the use of a rectangular blank shown at *G* in full lines results in a tip having inadequate width of contact with the supporting shank. While the tip indicated in dotted lines has a broad base upon which to rest, the tool must be scrapped when considerable carbide still remains on the tool. At the right hand of Fig. 6 *G* is shown a properly designed tool incorporating a blank dovetailed at approxi-

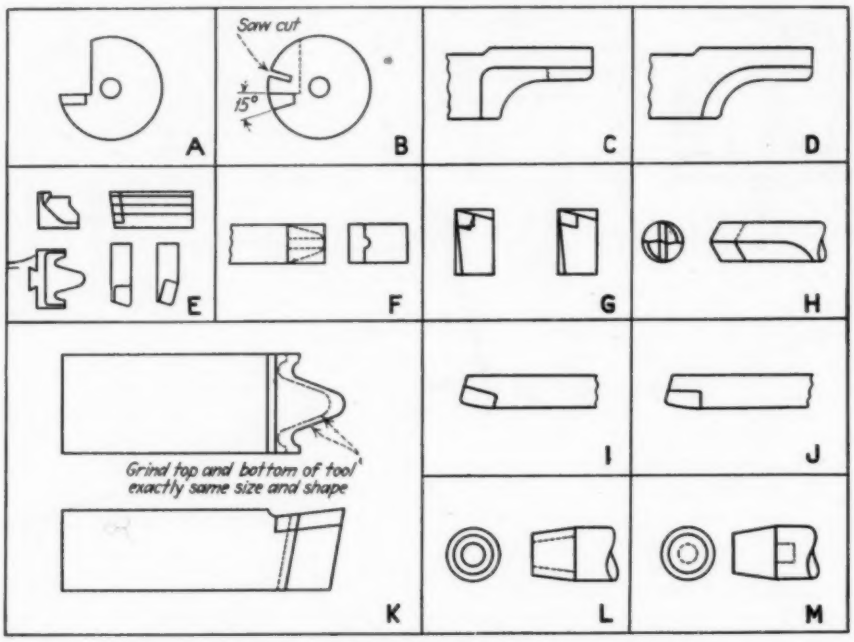

Fig. 6—What to avoid in carbide tool design is shown by examples of correct and incorrect construction

mately the side rake angle. The dovetail also operates to avoid any possibility of the tip being rotated out of its socket by a momentarily excessive load.

At *H* is shown a common method of tipping a flat drill to utilize a maximum amount of carbide and leave little or none after the last grind.

At *I* and *J* are shown two common forms of roughing tools having the same cutting edge contour. Inasmuch as proper grinding procedure dictates that, when dulled tools are reground, some stock should be taken off the end, the side and the top, the tip becomes progressively shorter, narrower and thinner. The design shown at *J* is superior to that at *I* because the tip width will remain almost constant throughout the life of the tool.

At *K* is shown a recommended design for flat forming tools. Because of the manner in which this tool is ground, successive regrinds parallel to the original lip surface will not cause the form of the cutting edge to lose size, a fault to which flat forming tools of other designs may be subject.

At *L* and *M* are shown two methods of applying a carbide tip to the end of a shank for the purpose of producing a mandrel or plug gage. It is a law of mechanics that when two materials of differing strengths are to be united by recessing one to fit the other, the stronger should be the one weakened by the recessing. The design shown at *M* is safer for the further reason that, if the thin walled shell of carbide of design *L* is subjected to heat, the steel mandrel inside will expand more than the carbide ring, and the unbalanced forces set up may be sufficient to rupture the carbide with loss of time and material.

Table I—Recommended tool angles for various materials—These data are based on turning with lathe tools at approximately 1/8-in. cut and 1/32-in. feed per revolution, except as noted

Material Cut	Tensile Strength Thousand lb. per sq.in.	Recommended tool angles in deg. Clearance	Side Rake	Back Rake	Cutting Speed ft. per min.	Recommended Cutting Fluid
Cast iron 150-170 BHN	18 – 26	4	10 – 12	0 – 4	275 – 350	
C. I. 1.5% Ni 170-195 BHN	20 – 28	4	8 – 10	0 – 4	250 – 300	
S. S. 20-30% steel scrap 2% Si 170-195 BHN	30 – 36	4	6 – 8	0 – 2	175 – 250	
C. I. 1% Cr 3.5% Ni 210 BHN	30 – 36	4	4 – 6	0	150 – 200	
Malleable C. I	.....	5	10 – 12	6	175 – 250	
SAE 1112 Bess. screw stock	70 – 90	5 – 8	12 – 20	6 – 10	300 – 400	
SAE 1120 O. H. screw stock	70 – 85	5 – 8	10 – 16	5 – 8	275 – 350	
SAE 1020 soft forging	63 – 80	4 – 6	10 – 14	5 – 7	250 – 300	Emulsion
SAE 1035	75 – 90	4 – 6	10 – 12	5 – 6	250 – 300	Emulsion
SAE 1050	80 – 100	4 – 6	10 – 12	5 – 6	175 – 250	Sulfurized mineral oil
SAE 2315 gear blanks	80 – 115	4 – 6	10 – 12	5 – 6	150 – 200	Emulsion
SAE 3120	80 – 110	4 – 6	10 – 12	5 – 6	150 – 200	Sulfurized mineral oil
SAE 52100	100 – 125	4 – 6	10 – 12	5 – 6	150 – 200	
SAE 6150	125 – 150	4 – 6	8 – 10	4 – 5	125 – 175	Sulfurized mineral oil
18 Cr 8 Ni stainless	85 – 110	4 – 6	10 – 14	5 – 7	150 – 200	Sulfurized lard oil
Hi C Hi Cr stainless valve seats	100 – 125	4 – 6	8 – 10	4 – 5	100 – 150	Sulfurized lard oil
Pure cast aluminum No. 43	19	8 – 10	12 – 16	25 – 40	500 – 1000	Kerosene
Dural No. 17 ST	58	8	0 – 3	6	200 – 300	Kerosene
Alcoa No. 132—LoEx	30	6	8 – 10	14 – 18	300 – 500	Kerosene and lard oil
Rolled copper	30	8 – 12	18 – 25	4	300 – 500	Dry or sweet milk
Cast yellow brass	25	6 – 8	....	....	500 – 800	Paraffin oil
Bronze, hard cast SAE No. 62	30	6	6 – 10	0	250 – 400	Paraffin oil
Phosphor bronze SAE No. 64	25	6	4 – 8	0	150 – 300	
Glass (drilling)	....	....	....	....	75 – 150	
Unfired clay and porcelain	....	15 – 30	....	10 – 15	300 – 500	
Copper & mica commutators	....	8 – 10	16 – 20	10 – 15	300 – 500	
Bakelite	....	8 – 10	8 – 12	4 – 6	500 – 800	
Casein products	....	8 – 12	4 – 6	0 – 3	300 – 500	
Hard rubber	....	8 – 10	....	....	300 – 400	

Chilled Cast Iron Rolls. 10-20 F.P.M. 3 deg. clearance. 0-3 deg. back rake. No cutting fluid used.

Tool Angles

Tool angles may be divided into three main groups:

1. Setting angles or angles the cutting edges make with the work axes,
2. Clearance angles,
3. Rake angles.

As previously mentioned, considerable gain in tool life can be made with acute setting angles. Frequently, the conditions imposed by the nature of the operation prohibit their use. Wherever possible they should be used.

The clearance angles should be as great, but no greater, than will produce a free cutting action. In general 4 to 6 deg. is sufficient, but for some soft metals and for most nonmetallic substances, rather large clearance angles are not only necessary but desirable.

Rake adds keenness to the cutting edge, gives freedom for the removal of chips, reduces the feeding and radial pressure, and for ductile metals, such as steel, materially reduces the extent to which the metal preceding the cutting edge is work hardened. For soft, stringy metals, such as aluminum, drastic rakes are necessary in order to get a satisfactory cutting action.

Brittle materials of the nature of cast iron do not require steep rakes, since they are not removed in the form of continuous chips and are not appreciably work hardened by cutting operations. Little or no rake is used on brass tools for a similar reason and because of the tendency of brass tools having rake to dig in and chatter.

It is impossible to fix arbitrarily the optimum rake angles for each particular material to be cut, since this most efficient rake angle will vary with the physical condition of the work, the cut, the feed and the speed as well as other variable quantities. For each class of material there exists fortunately, not a single value, but a range of angles within which satisfactory results can be obtained. In Table I the rake and clearance angles found through actual practice to yield good results are shown for selected materials.

Tool Setting

Tool setting can be dealt with briefly but nevertheless emphatically. The cutting point should always be on center. Various advantages have been claimed for setting the tool above or below center, but for the great majority of carbide tools, the fact that setting the tool on center permits the use of a proper minimum clearance angle overbalances all others. Setting a tool below center may make possible a still less clearance on outside diameter turning but changes the rake and may cause the tool to dig-in.

Spot Softening a Nitrided Case

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Nitriding has been considerably restricted because of the lack of a ready method of local softening when minor machining operations are required. The author describes a method enabling toolmakers to make adjustments after hardening

DIE-CASTING dies are an example of the need of local softening for nitrided surfaces. They are costly tools, designed for mass production of twenty to fifty thousand articles, based to a rather unusual degree on experience or trial. As a result, it is often necessary, after a few trial pieces have been cast, to make slight modifications in the die. Sometimes, after a portion of the order has been completed, wider alterations are necessary because of some modification in the design of the general mechanism.

In the past, before any such machining alterations could be effected, it has been necessary to soften the nitrided case of the entire tool; subsequently, to prevent spalling on renitriding, it has been imperative that the entire surface of the tool be machined in order to remove the original nitriding case to its full depth. This characteristic has occasioned considerable delay in production and made the cost of nitrided dies prohibitive.

Again, in our own plant, instances have arisen where, because of some change in the general assembly after production was in progress, alterations to the nitrided details were found necessary. Had "local softening" not been available, there would have been no alternative but to scrap these parts. Since our original development on this process, we have made extensive applications which have demonstrated its practicability and value.

With little detriment to the nitrided surface in the immediate area as illustrated at *B*, it now is possible to spot soften exceedingly small places. For instance, a nitrided case showing 1,000 Vickers Brinell hardness can be softened in such a restricted area that a ¼-in. diameter hole may be made with any standard high-speed drill, while the immediate surrounding area still shows around 950 V.B. hardness and the surface slightly further removed has the maximum hardness.

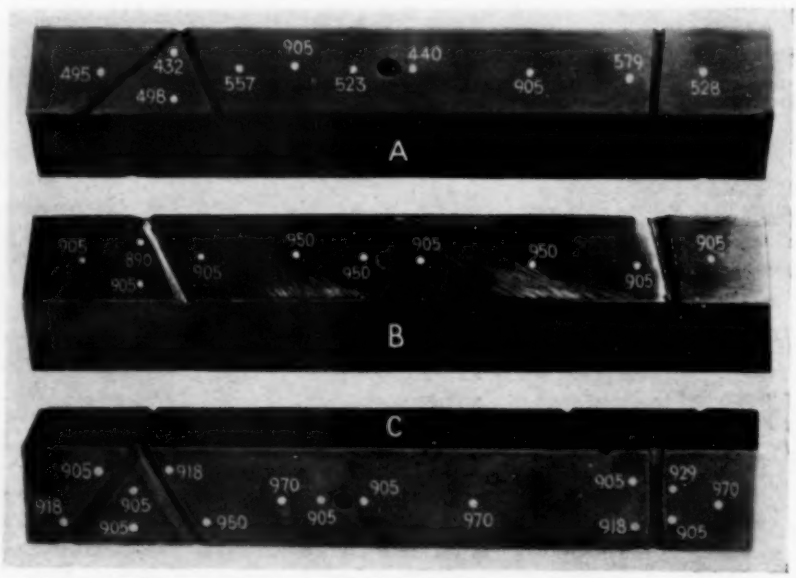
Narrow grooves and channels can, in this same manner, be treated to admit of the same freedom in machining without seriously impairing any of the adjoining portions of the case. Apart from the slight softening on the adjoining edges, already referred to, there is no evidence of any impairment of the case, and in addition a slight toughening effect arising from the elevated temperature has been found advantageous.

Either of two methods may be employed, and the same principles should be followed in each case. Essentially the process consists of uniformly heating the entire tool to 500-550 deg. C. and then fusing weld metal into the surface to be softened. This may best be accomplished by any of the established arc welding methods.

For non-essential working faces the ordinary soft steel welding wire may be used to "fuse soften" local areas of the case. This is for areas where the subsequently newly machined edges are not intended as working faces. These newly finished machined edges may contain an excess of the soft iron which would not give satisfactory hardness on these edges if renitrided.

Where the newly machined edges are required to resist wear or erosion equal to any other portion of the tool, a welding wire of nitriding steel should be used. On completing the machining adjustment, the entire tool should be renitrided.

The alternative method is the employment of the oxyacetylene torch and the fusion of a bead or patch of metal into the surface. By this method, however, the temperature cannot be restricted so locally, and it is advisable to bury the job in lime, sand or other non-conducting material, exposing only the area for operation, and to cover the immediate surface of the non-conducting material with asbestos. Alternatively, dependent on the size and shape of the job under



Effects of three methods of local softening for machining alterations are illustrated: *A*—acetylene torch; *B*—electric fusion; *C*—fusion with nitrided wire

treatment, compressed lime or asbestos masks may be secured in position.

In using the torch, a suitable size of burner should be selected to keep down the spread of the flame, and for effecting rapid fusion, advantage should be taken of the intensity of the heat near the apex of the cone. A small diameter welding wire should be used, and immediately an indication of surface fusion is noted, the soft iron or nitriding wire should be fused into it. Immediately after fusion, the entire job should be covered with non-conducting material and allowed to cool slowly to prevent subsequent distortion.

Heating the tool to 500-550 deg. C., although not essential, has the advantage that, in the electric fusion method, immediate deep fusion takes place. When the torch is used, excessive spreading of the heat is prevented, and thus the softening is confined more closely to the desired area. The preliminary heating to 500 to 550 deg. C. is in no way detrimental to the nitrided case, but on the contrary, has a slight toughening effect.

The illustration shows a 1¼-in. square experimental bar which was nitrided with production work on a 25-hour cycle and which showed a Vickers Brinell hardness of approximately 950 with a case depth of 0.019 in. These results have proved highly satisfactory for general industrial application. A greater depth of case or greater hardness in the range of 1,100-1,200 V.B., when required for special application, may be obtained at some additional cost by extending the nitriding cycle for a longer period, which may be 40 to 50 hr., but in any such instance, the case is equally amenable to this local softening.

Three Ways of Softening

At *A* is illustrated the effect of local softening by the use of the acetylyne torch. On comparing *A* with *B* the effect of flame spread and the consequent softening of the nitrided case may be observed. This, however, is of little consequence if it is intended to renitride the tool, as the heating conditions are not such as to cause oxidation of the nitrided surface, and hence there is no detrimental effect on the case resulting from renitriding.

B is typical of local softening by electric fusion and shows a strong contrast with *A* in that the softening is extremely local as indicated by the V.B. hardness numerals. Even at the apex of the inverted V, where the area is exceedingly small, it will be noted the V.B. hardness is 890, and close against this small area, the maximum hardness of 950 V.B. is still maintained.

C is an example illustrating the advantage of the use of a nitriding steel welding wire as the softening medium. In this instance, it is shown that after machining and renitriding, the newly machined surfaces and adjoining edges, carrying the nitriding welding wire, have a hardness practically equal to that of the original case. Many tests made on field service work similarly treated have demonstrated the value of this process.

Gear Lapping After Heat-Treatment

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Gear cutting technique has never reached the point where desired accuracy could be consistently obtained without subsequent corrective operations. Devices for this purpose appear on Patent Office records as far back as 1880. Because of a demand for greater quiet in gearing, the use of lapping has recently widened. The author reviews various methods and developments

IT IS IMPORTANT to differentiate between correction of gear teeth by the removal of an appreciable amount of stock and merely by a polishing operation in which no great amount of material is removed. This article treats the correction of gear teeth with an appreciable removal of material.

Recent advances in gear correction practice have made it possible to remove an amount of material hitherto considered impracticable, if not impossible. In fact, it is now economically practicable to remove all the distortion resulting from normal heat-treatment. Lap life has also been materially extended, and in certain instances, from 500 to 1,000 gears are corrected without effecting an error of more than 0.001 in. in the profile of the lap, even though the chordal thickness of the lap teeth may be reduced as much as 0.030 to 0.060 in. Results of this kind have ceased to be achievements and are considered normal routine in the better equipped gear manufacturing plants of today.

The early lapping practice was to run a pair of gears in mesh, feeding abrasives into the mating teeth. This was effective in improving somewhat the performance of the gears, but in the light of present-day standards, was a crude method for correcting the many inaccuracies to which gears are subject. One of the chief difficulties results from the occurrence of high spots left by the cutting operation. When a gear, having such high spots, runs together with another gear, the high spots on the first wear holes in the teeth of the second.

It is also customary in this wear-in procedure to operate the gears on parallel axes. Obviously the distance travelled in sliding contact by the tip of the tooth is greater than that travelled near the pitch line on the tooth. Consequently the abrasion of the tip is greater than that of other parts of the tooth. This often results in adding inaccuracies rather than in correcting them. As a matter of fact, many gears have been completely ruined by methods such as these.

In order to overcome this objection, a modification of the method uses an oscillating motion parallel to the axes of the gears while they are being run together. This does increase the cutting action at all points on the tooth surface but unfortunately does not materially alter the difference in cutting effect already mentioned.

A further development of this idea

Presented before the annual meeting of the American Gear Manufacturers' Association, Wilkinsburg, Pa., May 6, 1933.

was the introduction of a second motion, that is, one to vary the center distance between the gears in order to spread out the line of weakest lapping, which occurred on the pitch circle. This phase of gear lapping has reached its greatest development. Some have gone so far as to equip their machines with a radio attachment which makes audible the sound of the gears as they are being run together. In this operation, lapping is halted by the operator as soon as the characteristic sound has diminished to a minimum.

Under the above procedure the gears do assume conjugate shapes, but the tooth, when completely processed, does not take the form of an involute curve nor do the finished gears move with a uniform circular motion.

Use of a Separate Element

Another principal avenue of attack on this problem has been the use of a separate lapping element. This has resulted in increased lap capacity, as the material chosen for the lap is softer than the gear to be processed and is of such a character that it more readily holds the abrasive compounds. In fact, special lap materials increase the ratio of lap wear to gear wear to about 20 to 1.

Another practice involves the use of emery sticks, profiled to the shape of the teeth, and still another uses large worm laps made to correspond in angle with the hob with which the gears were cut. It might be said in passing that the large worm lap proved more or less successful, providing the operator used excellent judgment and the initial accuracy of the work gear was relatively high.

Worm lapping, wherein the worm is many times larger in diameter than the gear being corrected, has been used for watch pinions for the last 50 years. Originally these laps were made of cast iron and later of aluminum. In fact, the practice is still used in some plants turning out gears of this type. In view of the highly competitive nature of the industry and the low purchase price of the product, lapping time for watch pinions is necessarily quite limited.

Worm lapping has also been used to a limited extent in the recent past for automotive gears but without significant success. This process depends too largely on the judgment of the operator. If continued too far, the work is seriously damaged. Set-up also proves troublesome in that it is not possible to run the gears in their correct position until lapping is completed. The set-up has to be constantly adjusted and this has a tendency to throw serious variations in the tooth profile. These objections are intensified by the fact that high speeds are used and the cuts are taken lengthwise of the tooth profile. The contact period of the tooth point is greater than that of the pitch circle which, as previously explained, results in the irregular removal of stock. Because of the large lap diameter, recutting is expensive, and the difficulty of accurately reforming the lap teeth, which is done by grinding grooves in the worm, is easily recognized.

Still another effort to solve the troublesome variation in the amount of cutting at different points on the gear tooth entailed the use of a master internal lap having the same number of teeth and profile as the work gear. The work gear is reciprocated inside this special lap contacting first one side and then the other of its teeth. An intermittent indexing spreads excessive wear over the several lap teeth. The result of this type of lapping, however, shows little improvement in the eccentricity of the finished product. Any given lap rapidly assumes the characteristics of the average of the gears processed. If excessive error occurs in several consecutive pieces, the lap tends to take the same shape as the work units.

Another objection to this means of correction is caused by the lengthwise cutting on the gear teeth which is inclined to produce a washboard effect and excessive noise in the operation of the completed product. It is also quite difficult to secure accurate master laps. The current practice in producing the lap is to cast it over a master gear and then run it into shape with a variety of selected gears. This practice eliminates the variation caused by rolling contact with other gears but introduces a factor of excessive wear, as certain teeth of the lap are seriously scored.

Split Worm Lap

Another variation in gear correction equipment is the use of the split worm lap which takes up backlash between the gear and lap while running on correct centers. This results in half of the worm operating on one side of the tooth and the other half on the other side. The tendency of this action is to cut tooth profile rapidly but at the sacrifice of angular correction.

The internal gear has also been used in another way, that is, by allowing the work gear to roll with the lap. The action here successfully corrects tooth profile but at the expense of machine time. Another obstacle to the use of the method is that of obtaining internal gears of the necessary size and accuracy.

Another method of gear correction relies on the use of a rack lap. The teeth of the work gear are parallel to the length of the rack teeth. This method corrects gear inaccuracies with relative success except index error. Inasmuch as any given tooth on the work gear continuously contacts the same tooth on the rack, wear caused by index error becomes cumulative. The initial cost of the rack and the cost of its accurate recutting has also proved to be a serious objection.

With the increasing pressure of the automotive industry for silent transmissions, it has become imperative for the gear manufacturer to eliminate errors in gear teeth to a much higher degree than was heretofore considered necessary. These errors include profile, index, eccentricity, helical angle and quality of finish.

New Practices

These insistent demands for higher quality have resulted in the development of two new lapping practices within the last three years. Both are based on the use of a separate lap and a crossing of the axes of gear and lap. The first of these is known as cramp lapping, in which the lap tooth is given an abnormal thickness and in which the feed reduces the center distance between gear and lap. The lap teeth contact both sides of the gear tooth; cutting is accomplished by a lapping compound fed into the gears during operation.

Cramp lapping is rapid and is an ideal means of correcting excessive eccentricity or index. It has become standard practice in a number of progressive shops manufacturing automotive gears. In explanation, let me say that any material change effected in the center distance between gear and lap is compensated by a change in the angular setting of the axes, inasmuch as the lap and work gears mate in the same way as a pair of skew gears. This angular relation of the two axes is controlled by a vernier fixture on the machine column. The setting is controlled by the use of an angle checking fixture which indicates the tooth error by the use of a rack tooth and integral sine bar. The radius of the sine bar is the same as a division on the vernier column scale of the lapping machine.

Although the worm lapping process was the first to use crossed axes, the angle between the axes in that process is approximately 83 deg. The new practice of crossed-axis lapping introduced in 1930 reduces this angle to less than 30 deg., and it frequently ranges below 10 deg. The angle used in any given case is the difference between the helical angles of the gear and the lap.

The results attained by those newer methods have been so significant that

practically 75 per cent of the lapping tools purchased since their introduction incorporate the new principles. One outstanding case comes to mind of a set of gears having the following errors: involute, 0.004; eccentricity, 0.005; cumulative index, 0.008; helical angle, 0.005 on a 3-in. radius. These gears were corrected to a final involute error of 0.0005; eccentricity, 0.001; cumulative index, 0.001; helical angle, 0.001 on a 3-in. radius. Although considerable material had to be removed to attain this result and backlash was considerably increased, it is an extreme example of what can be done by means of the newer lapping methods.

In the second of these methods, known as power tailstock lapping, the center distance between gear and lap remains constant, and a power tailstock is used to effect a braking action on the work gear, which is driven by the lap. After the work gear has been driven a given number of revolutions in one direction, rotation is reversed and progresses in the opposite direction a number of revolutions to complete the cycle. The brake operates throughout the continuous cycle, first in one direction and then in the other. Thus both sides of each work gear tooth are given the same amount of processing. As in cramp lapping, above described, the axes are crossed. In both methods, an automatic electric reversing and timing mechanism controls the number of revolutions.

Lapping Materials

The cutting or lapping compound has also been given a great deal of study and has shown remarkable improvement in recent years. By the improvement of lapping compound, lap life has been raised from approximately 100 gears to 500 and as high as 1,000 in special cases. A lap which was used for automotive transmission gears shows a total wear of 0.079 in. in the chordal thickness but a variation in profile of only 0.001 in.

Too much attention cannot be devoted to the proper choice and inspection of grain size and quality in a lapping compound. There is a vast difference in the character of individual grains in any given size material. For instance, grain specified for abrasive paper is quite unsatisfactory for gear lapping because it contains a high percentage of needles and slivers. Grain for lapping compound should be of a rounded, irregular shape but never needle-like. Tests have proved the assertion that efficiency of cutting action and lap life can be greatly increased by a proper choice of grain and lubricant.

In our work, we have used two lubricants, one an oil soluble solution for washing in kerosene and the other a water soluble solution for washing in oil or soda water. The same size and quality of grain are used in each and the same amount of grain. Nevertheless, by carefully conducted tests, the water soluble compound is much more efficient than the one having the oil base. I do not believe the average shop man appreciates the potential saving available to him in the proper choice of a cutting medium.

Standard lapping time today for reasonably well cut gears is about two minutes per unit having a 1-in. face and 4-in. diameter. This assumes reasonable control of gear cutting and heat-treatment. We have found in other shops that machine time for lapping gears of similar size amounts to as much as five minutes and in still others, handling carburized gears inaccurately machined, machine time has amounted to as much as ten hours. Errors of this magnitude should be eliminated by adequate control of gear cutting and heat-treatment.

I recall one job having an eccentricity of 0.010 on a 5-in. gear. The teeth were out of parallel with the axes as much as 0.010 in 3 in. and the index jump from tooth to tooth was as high as 0.004 in. The holes were ground out of line with the teeth to the extent of 0.005 in 3 in. Such a condition, of course, requires supervision rather than lapping.

One of the finest runs I remember was a lot of 30,000 gears. The rejection for gear noise after lapping was only 1 per cent, and the lapping time averaged one minute per gear. The lap life on this job was approximately 900 gears per cutting, and the lap was recut twice, which gave a total life of 2,700 gears. These were standard automobile transmission gears of several well known designs which were accurately cut and heat-treated.

When excessive distortion occurs because of high carbonized heats on large gears, it has been found advantageous to take a single roughing cut with a grinding machine so as to remove this excess before final lapping. On a recent test, in which the grinding time on 12-in. diameter gears was 67 min., it was possible to take a single grinding operation of 15 min. and lapping time of 6 min., a total of 21 min.

Oil-Treated Gears

In the lapping of oil-treated gears, the standard lapping time varies from one min. to 4 min. on gears of 1-in. face and 4-in. diameter, and the proportional size of the gears indicates the increased lapping time required for the same cutting and heat-treatment conditions.

The use of accurate laps in the finishing of heat-treated gears gives the shop operators a clear indication of the errors in the cutting, as the high parts are easily recognized. On production runs, the cutting operations are frequently subject to prompt investigation because of the appearance of the gears after normal lapping, which shows the profile or angle of the gears to be in error.

Localized Burring

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When overhauling shop methods recently I found that at least 25 per cent of the operations for metal removal were burring, of one type or another. Countersinks were used in the drilling section; abrasive paper, scrapers and files in the assembly department. In painting and enameling, men would file castings and pressed metal cases. Even in the plating shops the foreman had introduced a special fast cutting dip for modifying the rough sharpness of blanked and pierced parts.

One of the difficulties of properly controlling burring operations is that the time occupied for an individual component is usually very low, which makes rate fixing of individual operations difficult unless large batches are scheduled. For the factory in question it seemed best to form a burr removal department for this operation.

The idea was born from the geographical location of the polishing shop and adjacent sand blasting hut, especially as these were next to the electroplating departments and painting and cellulosing shops. It was arranged that all parts having raw edges or burrs should be passed to the foreman of the polishing shop for his inspection and choice as to the method of burr removal to be adopted.

For the removal of burrs on holes the horizontal tapper fitted with a suitable rose bit was found particularly effective since the handling of the various parts was easier than on the ordinary type of vertical drilling machine. Wherever possible, however, burr removal was accomplished by sandblasting which proved cheaper and better than other methods, being less likely to damage the parts themselves and at the same time leaving an admirable surface for taking most modern finishes. After a short time study in the new department it was found possible to standardize on a number of prices according to the size and shape of the parts. These standards were handed to the foreman and were used in connection with all components thus reducing the cost of rate fixing and considerably simplifying the accounting.

Bearings for the Soviets

Part IV–The Organization, How it Was Set Up and How It Functioned

FRANK SCHUBERT

As in most elaborate organizations the one at Kaganovitch grouped itself into Doers, Talkers and Objectors. Management was through the usual Soviet "triangle" with operating authority in the operating manager or director

DURING the planning of the bearing plant project, the personnel of the staff could be classified in the following groups: Group 1, technically trained; Group 2, technically trained and experienced; Group 3, technically trained and idealistic; Group 4, experienced in the ways of the development of Soviet projects.

The members of Group 1, who were technically trained but had had little working experience, were a small group of technical school graduates who were sent to America or to other countries to acquire, first hand, what operating experience was available, along with assisting in some of the layout work at Commission Headquarters. These young men were sincere, hard-working, eager for acquired knowledge, thorough, and in the make-up of their reports, displayed good analytical ability.

Key Men Were Practical

The experienced men of Group 2 were, of course, the working basis of the organization, inclined very little to purely theoretical tendencies, but insistent that so-called practical proposals be supported by theoretical analyses. While these engineers had had no experience in the manufacture of anti-friction bearings, they had had experience in the operating or engineering control of factories in Russia. They drew upon this experience in making their decisions as to the workability of proposed processes, methods, and controls. Some among them were ready to assume the responsibility for carrying out plans which, by careful analysis, had been shown to be adapted as nearly as possible to the manufacturing requirements of the product and also to Russian conditions. Others, fortunately in the minority, did not wish to assume such responsibilities but rather to avoid them, preferring to increase the ultimate load on divisions other than those over which ultimately they would assume acting supervision.

The technically trained idealists of Group 3, also few in number, were of the professional type, inclined to recommend the most expensive methods and equipment as well as to set standards of excellence that were ideal rather than practical; undoubtedly sincere, but visionary to the point of believing that ideal operating results were as readily obtained as the "lecturing" exposition of them was written. (This is not intended as an indictment of professors in industry. Some actual professors transferred to industry from Russian technical schools are doing very excellent work.)

Such members of the staff as those who had had very little technical training (and those who had not were usually ready to admit it), I have placed in Group 4. Supposedly, these men were fitted to observe, to analyze, or to lead the work, as a result of experience they should have gained in the development of other projects. Naturally, they were not of uniform ability in the performance of these duties. Occasionally the observations missed the essential details, the analyses were rather desultory, and the direction partook of mere stubborn resistance in conference, with no supporting evidence, or with evidence confined to mere oratorical outbursts. Such, fortunately, were the exception and not the rule, the majority displaying a keenness of insight and an inherent leadership which convinced one that the "brain trust" of Russia did not pass with the old regime.

In the operation of the plant, such lines of classification seemed to blend or to disappear, probably because of the natural welding of an organization some two years in the making. There merged an apparent group classification of Doers, Talkers, and Objectors.

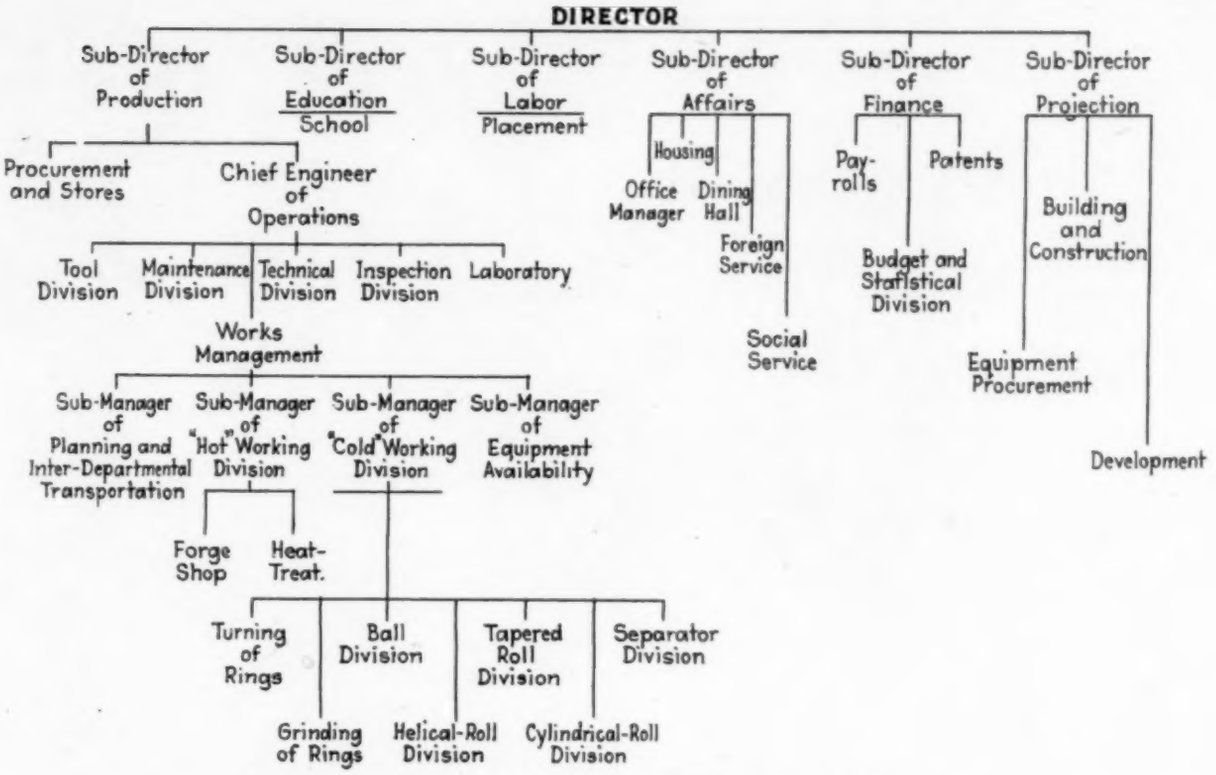
The Doers, somehow, managed to work out their assignments, even against tremendous odds.

The Talkers preferred wordy dissertations of fatiguing length to explain handicaps (of which the staff was quite aware) which hindered or prevented the accomplishment of their tasks.

Operations of the Objectors

The Objectors appeared to find ample time for destructive criticism of their fellow workers, succeeding at times in building up a personal animus, thus making one more problem to be overcome. There were no restrictions of any sort on even the publication of criticism of persons, processes or departments. This freedom of speech was called "self-criticism" and under it one scarcely could expect criticisms to remain constructive or to be based entirely on fact. It was urgently proposed that the plant daily newspaper could be a very constructive builder of morale and unified effort. In this, the directorate concurred, but the writer did not remain to see it functioning exclusively as such, although the editorial staff spent their efforts and their editorials in the effort to accomplish it.

Prior to the end of the third year of the Five Year Plan, all Soviet manufacturing had been under the control of one central group; but at the beginning of the fourth year, this was divided into two central groups or commissariats: one for the light industries and one for the heavy industries. The light industries were those including wearing apparel, household goods, etc.; the heavy



Organization chart of the Kaganovitch bearing plant in Moscow. Note the important position of the chief engineer of operations

industries, covering iron and steel production, shipbuilding, automotive, etc. The writer is not conversant with the diversification of products in these two groups, but they would appear to be classified as light industries for consumers' goods and heavy industries for producers' goods.

VATO, the automotive "trust," being a part of the heavy industries group, controlled among others the Kaganovitch bearing plant. With the acquisition of the old SKF bearing plant in Moscow, with the projecting of a third bearing plant in the Urals, and with a possible fourth to come, it is reasonable to assume that eventually the bearing industry will be set up as a separate unit directly under the central heavy industries group. This would be logical if the final resulting total bearing production is to be used in other fields than just the purely automotive, to which the product of the Kaganovitch plant is confined.

The accompanying chart is a general scheme of the organization plan of the staff of the Kaganovitch bearing plant, and gives an idea of the functional grouping of this executive staff about as it was operating, four months after the official opening of the plant. The chart is not a copy of the organization chart current at that time, but represents the writer's experience with the actual "workings" of the organization. There may have been other functional groups operating, but with whom the writer had little or no working contact. Each division in the factory group (forge shop, turning, etc.) operated rather as a separate plant, "buying" from the preceding division and selling to the succeeding one. Hence each division had its own bookkeeping staff, its own planning staff, its own statistical staff, its own technical staff and its own patent review staff. These so-called sub-staffs theoretically were to be under the supervision of the functional groups of like classification in the general office staff. But actually this was scarcely the case. The sub-staffs gradually took on the active inclination to be simply a section of the division in which they were working, some more so and others less. For easy workability without staff clashes, this was not inadvisable, and would eliminate some duplication of paper work.

Conventional Purchasing

The procurement division operated about as a normal purchasing department does, buying on specifications issued by the laboratory, to a schedule issued by the planning division, sending representatives by airplane to urge vendors to greater efforts, and urging the substitution of other materials or other specifications when a source failed to deliver standard materials. From it originated proposals to buy foreign materials when home sources were going to be unable to step up production in accordance with increasing requirements.

The tool division at one time was under the control of the works management, but this seemed to be quite an exception to the general organization plans of the automotive group. Hence this was changed per the chart shown. At that time, the sub-manager of equipment availability began to function also as the liaison between the tool division and the works management group.

While ostensibly the inspection division reported to the chief engineer of operations, actually, on questions of quality, it was authorized to go beyond his authority and that of VATO direct to the central control of the heavy industries group or Commissariat of Heavy Industry (NKPT). Apparently, this was a sort of "back-wash" from difficulties encountered in the control of quality at Stalingrad.

The patent division is shown on the chart as reporting to the sub-director of finance only because his approval of patent bonuses was required when such payments exceeded a fixed maximum sum. Otherwise, the patent division operated quite independently. The patent division has the abbreviated name BRIZ (pronounced "Breeze"), meaning bureau of rationalization and invention,

Battery of FIAT ball-grinding machines. The illustration gives an idea of the building construction and working conditions

used throughout Soviet industry to foster the inventive genius which nearly every factory employee hopes to discover within himself.

Each one of the factory divisions had its own equipment maintenance group and there was considerable discussion as to whether the maintenance division should assume responsibility for and supervision of these sub-groups or if they should receive instructions from the divisions in which they were operating.

Probably the above are the most interesting side-lights on the functional operation of the staff as indicated by the chart. It was quite difficult to secure the desired functional operation, group and division managers normally attempting to follow line operation, when the assumed "dictatorship" in their own departments seemed on the verge of being usurped. Undoubtedly, this was not a result of departmental jealousies, but a shunning of co-responsibility with other departments. The elimination of this tendency to avoid co-responsibility was the constant problem of the works management group, and in leading the work of this group, the writer was told that he was not sufficiently "heavy-handed" in pressing the division managers on this point.

The budget and statistical group of the financial division, operating as the progenitor and perhaps the guard of the "Promfinplan" (production - financial plan), organized a sort of monopoly on information and it was difficult for the planning division to secure actual production figures until the official daily report of the statistical group had been issued. The exact reason for this was never quite clear to the writer, but the statistical group was quite ready to accuse anyone who objected to their system as being greedy for more authority. However, this scarcely seemed to apply, for it was a case of throwing more paper work into one group (officially) and making less in another. Continuance of the "monopoly" simply meant that the planning division sent runners into the plant daily to get the figures at the time they were known to be available in the respective divisions. The idea may have been involved somehow in the very prevalent belief, a year ago, that it was unthinkable that the same works management group could issue a detailed working schedule and then carry it out, maintaining, the while, the proper degree of production urge. This created the impression that production plans were to be issued by, and "policed" by the statistical group, which again would be the bearers of bad news, in the case of production failures; such group having no working connection with the works management.

Control Through Budget Group

In this budget and statistical group lay the most potent of all the controls, as far as improving operating efficiency was concerned. Probably, the sub-director of finance realized this, for when he was appointed to the Staff of the bearing plant from the Central Promfinplan Group, he announced that he would be absolutely rigid in his budget control of divisional expenditures. However, the first glimmer of the coming functioning of its efficiency control possibilities came in a small conference held early in June, 1932. The discussion was to indicate the proper department to which should be charged the unbudgeted cost of having put through a lot of forgings which were too hard to be machined in the turning division. These unbudgeted costs included the loss of material, broken cutting tools, damaged chuck jaws, machine down-time, idle labor, and normalizing and re-annealing. The divisions involved were laboratory, forge shop, heat treating, inspection, and turning. The heaviest costs involved were in the turning division, the budget of which did not include such disproportionate losses. The arguments included the following charges: "The inspection division is at fault for having released these rings to the turning division"; "The rings were so heavily decarbonized that the hardness tests (Rockwell) indicated they were okeh"; "The rings should have been normalized before annealing (which was not normal practice) because they were forged at too high temperature"; "The forging machine operators cannot be held responsible for these incorrect temperatures; where were the furnace observers assigned by the laboratory?"

Along with the financial control of the budget and statistical group, there were the labor, the party, the planning, and the quality controls. Normally, in the direction of the affairs of any department or of the entire plant, there were three nominal managers or directors. One was the operating manager, a second was the representative of the party, and a third was the representative of labor. This third manager was elected by the department, division, or plant employees, as the case required, something as a union official would be elected, although customarily his elective appointment would require the accedence of the operating manager. To all appearances, the party representative was an appointee either of and from the district party organization, or from the

party membership in the department involved; comparing perhaps with American municipal appointees. (See foot note.) These three managers formed what was called the "Tree-ooglóke" or triangle of management. The appointed operating manager or director, who might or might not be a party-member, was secured in the normal way in which any industrial enterprise would secure such executives as needed. No interference was brooked in his normal operative efforts, from the other "angles" of the "triangle." They were not to be obstructionists, but were to cooperate in the management of the division by securing party and labor organizational force in the carrying out of the manufacturing program. Through them, of course, the party and labor organizations exercised their controls of ideals, labor classifications, social conditions, factory working conditions, etc., along with perhaps some operative duties in their department. The operating manager of a factory division was assisted by a divisional chief engineer.

It is conceivable that in the placing of such executives as these party or labor representatives, there would be some who would have either a false impression of their power as such, or the impulse to abuse what powers they did have. These, being classed as obstructionists, were removed and a formal hearing of the charges placed against them was held. Such hearings would become a time for a general voicing of verbal complaints against the operative tactics of anyone in the organization, or against infractions of the executive code of ethics governing the actions of industrial executives in most countries. Thus, "shop gossip" could be stemmed openly and effectively. With the possible exception of favoritism displayed in the assignment of living quarters, these conferences or hearings developed no problems which an American factory executive does not face, at one time or another.

Toward the end of each month, after the factory divisions had received their detailed schedules for the following month and their preliminary schedules for the two succeeding months, a series of budget conferences were held in the office of the sub-director of production. All departments or divisions, such as procurement, labor placement, etc., involved in the schedule or budget of the division under discussion, were represented at such a conference. The schedule and the budget were reported on in minute detail, it being the primary duty of the sub-director of production to see that the proper steps were taken to insure fulfilling of the "sales" schedule of finished bearings, and also that the costs of carrying out such schedule were correctly budgeted and in accord with the annual "Promfinplan." Effectively, these conferences were a planning control, but were supplemented by other sessions when any division failed to fulfill its schedule by a margin calculated to result in a pyramided failure in other departments.

Furthermore, each morning at 8:30, a works management conference was held, attended by four members of the works management staff. Here, the submanagers voiced their needs for action from other functional groups to prevent production failures in the future and to correct current troubles. Then, on a rotating daily schedule, each of the factory division managers was called in for a half hour conference with the submanager to whom he reported, and the sub-manager of planning; the discussion being confined to current troubles in that division or failures in its schedule.

Monthly Engineering Conference

Another activity, best placed under the activity of production control was the monthly meeting of the Society of Engineers and Technicians. Aside from those meetings of this group which were confined to their own social service or to collective bargaining, these meetings were a review of the failures and the accomplishments of the various divisions during the preceding month. Questions were asked, complaints made, and advice given, largely on technical matters, every effort of the president of the society being made to hold the meetings to strictly reviewing and constructively critical channels.

Quality control was exercised chiefly by the laboratory and the inspection division, the former being charged with the quality control of material analyses and physical properties.

The functional position of the inspection division has been described. The departmental adherence to the exact instructions of the divisional chief were marvelous to witness, although at times a bit disastrous, when, in his absence, incomplete or doubtfully correct instructions were discovered. The divisional routine was to follow the exact letter of the specifications or drawings. Supplementing the inspection division in the control of quality were two salvage committees, meeting in the afternoon of the last or fifth working-day of each week. Each of these committees comprised a representative of the technical division, and one of the works management division, together with the chief inspector whose operators had rejected the parts in question. Aside from disposing of the rejected materials or parts, these committees initiated changes in routine, processes or standards, where required to eliminate recurrences of the rejections.

(Fourth article of a series. Preceding articles appeared in Vol. 77, No. 8, page 229; No. 9, page 273; No. 10, page 296.)

More About Balancing
Discussion

W. R. NEEDHAM
Stafford, England

John R. Godfrey's note (*AM*—Vol. 77, page 26) is well worth serious consideration. In the absence of a balancing machine very much indeed depends upon the experience of the person involved.

Many works engineers are apt to overlook the practical importance of dynamic balancing. The writer has had difficulty in getting shop men to appreciate that there is a real difference between static balancing on the rails and running balance. They often fail to visualize the harmful effect an unbalanced couple may produce. Management should insist that the shop foremen among others shall be educated in the first principles and theory of balancing.

It is often well worth while to balance rotating parts in detail and in bulk. Where the component parts are of short axial length, static balance is usually all that is required. Should the rotating system be an assembly of disk-like details, dynamic balance is seldom necessary provided care has been taken to balance each separately. Any dynamic couple there may be will be so slight as to be of small practical importance.

Known out-of-balance masses should be corrected in detail as nearly as possible. It should be the designer's job to see that the necessary correcting particulars and instructions are given. Another sound precaution is to insure that as nearly as possible salient masses of equal nominal weight, which are symmetrically disposed in the circle, shall balance each other out. To this end it is advisable to weigh each such mass carefully and place them individually so that diametrical opposites are the closest possible match.

It should be understood that naturally the writer had no part in labor elections or in party appointments, so the above outline of the methods of selecting these appointees is the understanding of the writer, acquired in the carrying out of his normal executive duties, or by casual observation of bulletin boards or newspapers. In his entire experience in Russia, at no time was there anything which "smacked" of labor or of party interference in the accomplishment of his individual duties. Possibly, a few so-called "party" complaints would have been ironed out better in the office of the works management before publication of them in the plant daily paper. However, complaints so made were answered in print, instead of in conference, and these occasions no doubt would become more infrequent as the real constructive force of the daily paper, Za Sovietski Podshipnik, was recognized.

Motion Study Speeds a Simple Assembly

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Here is an easy task of assembling a bolt and three washers that might be encountered in any shop, large or small. Motion study, supplemented by the most elementary fixtures, increased output 50 per cent and lessened fatigue

ALTHOUGH time study for rate setting has been widely adopted by industry, motion study has been used far less. There is no good reason for this except that motion study has been misunderstood. Its meaning and purposes have been badly stated and furthermore the micromotion study technique and the use of the motion picture camera have tended to complicate motion study in general.

In reality motion study very often makes possible greater savings in manufacturing costs than does the combined use of time study for rate setting and wage incentives. Before going into a discussion of motion study it is essential that the broad meaning of time study be stated.

Time study is the analysis of the methods, materials, tools and equipment used, or to be used, in the performance of a piece of work; the development of the most economical way of doing this work; the standardization of these methods, materials, tools and equipment; and the accurate determination of the time required by an average man to do it. From the above definition it is apparent that time study in this broad sense serves a three fold purpose. These three objectives of time study may be shown in outline form as follows:

1. Motion Study—finding the most economical way of doing work.
2. Job Standardization—putting the new method into effect and training the operators in this new way.
3. Rate Setting—determining a day's work—determining the number of pieces that the average worker should produce per hour using the method which has been determined by motion study.

Fig. 1—Bolt and washer assembly. *A*—⅜- by 1-in. capscrew. *B*—lockwasher. *C*—steel washer. *D*—special rubber washer

From this three-fold definition of time study it is seen that motion study occupies first place. Motion study proper is a study of the motions of the worker with the purpose of eliminating unnecessary motions and finding the best sequence of the necessary motions in performing work. It is necessary to remember that the method of greatest economy in dollars and cents is the method to be used rather than the method of greatest economy in motions used by the operator. For example, a magazine fed, motor driven pencil sharpener might be the *best* device for sharpening pencils, but for the small office, the small hand operated one is most economical. Therefore, what may be the best way in one case may not be the best way in another case. The determination of the method of greatest economy for a specific job, giving consideration to all factors affecting the work, is the purpose of motion study.

Motion study makes possible the performance of the work in the easiest and fastest way. It saves the worker's energy, reduces labor cost for the management and makes possible a lower unit cost of the product to the public. It should be understood from the beginning that motion study does not tend to "speed up" the worker but rather to make the work easier and less fatiguing. Motion study proposes that those methods be used which permit the worker to use his inherent capacities to the best advantage. Investigations in physiology and psychology supply certain information which can be put to practical use almost everywhere.

Motion study does not require expensive equipment, apparatus or tools and it is therefore as applicable to the small manufacturer's problems as it is to the large one's. Often a rearrangement of the work place or the use of a simple jig or fixture to permit the operator to comply with the principles of motion economy will bring about unbelievable reductions in the time of performing work.

There are certain rules or principles that can be applied to improve the effectiveness of a worker's motions. In order to be more specific as to just how motion study may aid in reducing the time of doing work, some of the simple rules or principles that promote motion economy will be stated and an illustration will be used to show more clearly what is meant.

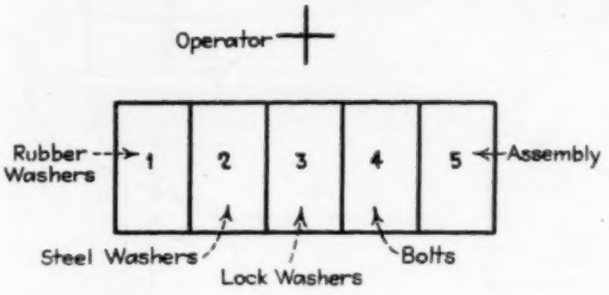
Six Principles of Motion Economy

The following six principles are just a few of the many that may be used to promote more effective methods of doing work.

1. Tools and materials should be located *around* the work place and as close to the point of use as possible.
2. Motions of the arms should be in opposite and symmetrical directions, instead of in the same direction, and should be made simultaneously.[1]
3. The two hands should preferably complete their movements at the same instant.

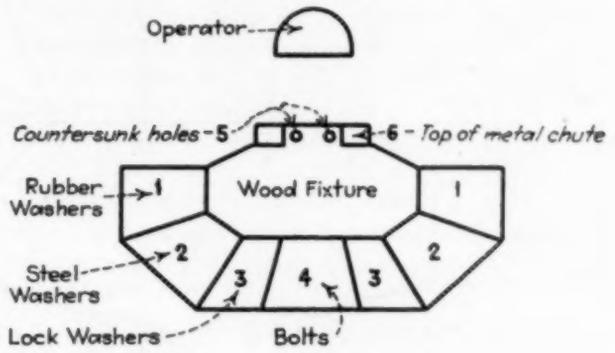
[1]This, as well as the third rule, was first stated by F. B. and L. M. Gilbreth, "A Fourth Dimension for Measuring Skill for Obtaining the One Best Way to do Work," *Soc. of Industrial Eng. Bull.*, Vol. 5, No. 11, p. 6, November, 1923.

Fig. 2—Bolt and washer assembly—old method



1. Left hand carries the finished assembly to container 5, while right hand moves to lock washers in container 3.
2. Left hand releases assembly into container 5, while right hand grasps one lock washer from container 3.
3. Left hand reaches for bolt in container 4, while right hand carries lock washer to a position directly in front of the operator.
4. Left hand grasps a bolt from container 4 and carries it to a position directly in front of the operator, while right hand positions lock washer so it will be ready to slip onto bolt.
5. Left hand holds bolt while right hand assembles lock washer on bolt.
6. Left hand holds bolt while right hand moves to stock of plain steel washers in container 2.
7. Left hand holds bolt while right hand grasps steel washer.
8. Left hand holds bolt while right hand carries washer to bolt.
9. Left hand holds bolt while right hand assembles steel washer.
10. Left hand holds bolt while right hand moves to stock of rubber washers in container 1.
11. Left hand holds bolt while right hand grasps washer.
12. Left hand holds bolt while right hand carries washer to bolt.
13. Left hand holds bolt while right hand assembles washer.
14. Left hand begins to carry finished assembly towards the container 5 while right hand releases the finished assembly.

Fig. 3—Bolt and washer assembly—new method



1. Left hand and right hand simultaneously move to stock of rubber washers in containers 1.
2. Left hand and right hand simultaneously grasp rubber washers with the index and second fingers.
3. Left hand and right hand simultaneously slide rubber washers to countersunk openings, and position them in the fixture at 5.
4. Left hand and right hand simultaneously move to stock of plain steel washers in container 2.
5. Left hand and right hand simultaneously grasp steel washers.
6. Left hand and right hand simultaneously slide plain steel washers and position them in openings in fixture at 5.
7. Left hand and right hand simultaneously move to lock washers in containers 3.
8. Left hand and right hand simultaneously grasp lock washers.
9. Left hand and right hand simultaneously slide lock washers and position them in the openings in fixture at 5.
10. Left hand and right hand simultaneously move to stock of bolts in container 4.
11. Left hand and right hand simultaneously grasp bolts.
12. Left hand and right hand simultaneously carry bolts to the washers which are already positioned at 5.
13. Left hand and right hand simultaneously position bolts preparatory to inserting them into washers at 5.
14. Left hand and right hand simultaneously assemble bolts.
15. Left hand and right hand simultaneously lift assembled bolts and washers and carry them slightly to the left and the right and release them into the top of the chute at 6.

4. "Drop deliveries" should be used wherever possible.
5. Gravity feed containers and bins should be used to deliver the material as close to the point of assembly or use as possible.
6. It is usually quicker to transport small objects by sliding than by carrying.

The six principles named above have been selected because they can all be explained and illustrated by means of the bolt and washer assembly about to be described. In the old method of performing this operation each of the six principles stated above was violated, while in the improved method each of the six principles was complied with. The improved method brought about an appreciable saving in time and a reduction in the fatigue to the operator.

Bolt and Washer Assembly

A manufacturing concern uses eight bolts $\frac{3}{8}$x1" fitted with three washers each, Fig. 1, in the final assembly of one of its products. It greatly facilitated the final assembly of the product to have the three washers previously assembled onto the bolt. Consequently the bolt and washers were assembled by girl operators at benches in the light-assembly department.

Old Method of Assembly

The bolt and washer assembly was originally made in the following manner: Containers with the bolts, lock washers, steel washers and rubber washers were arranged on top of the bench as shown in Fig. 2. The operator reached over to the container of bolts with her left hand. She picked up a bolt with her left hand and brought it up to position in front of her. Then with the right hand she in turn picked up a lock washer from the container on the bench and placed it on the bolt, then a plain steel washer and then a rubber washer. This completed the assembly and with the left hand the operator disposed of it in the

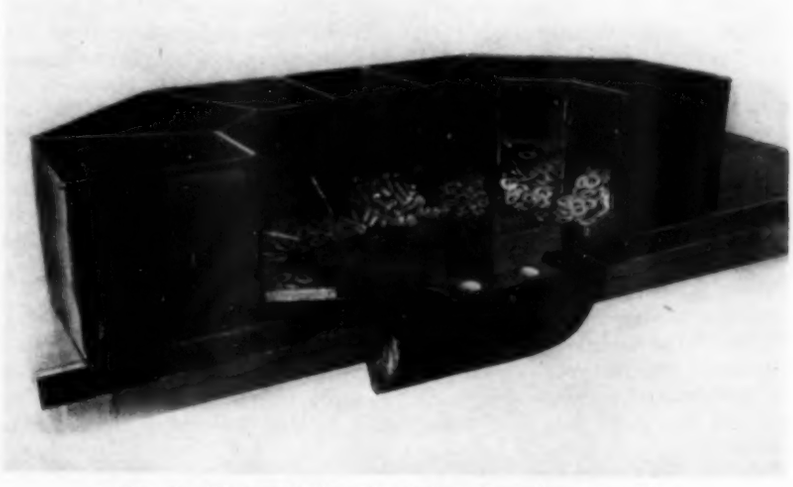


Fig. 4—Bins and chute for bolt and washer assembly

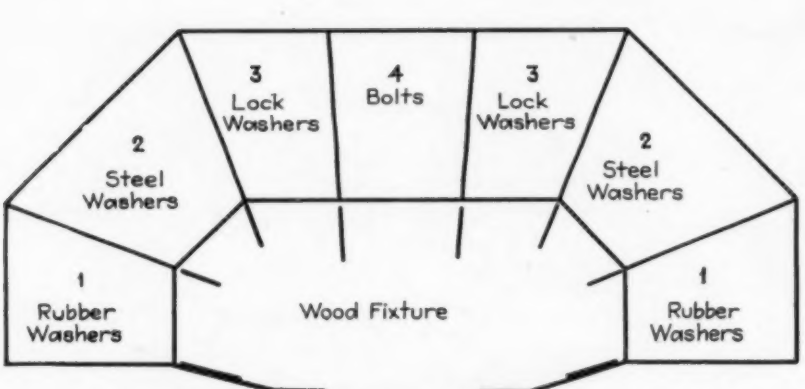


Fig. 5—Layout of bins for bolt and washer assembly—top view

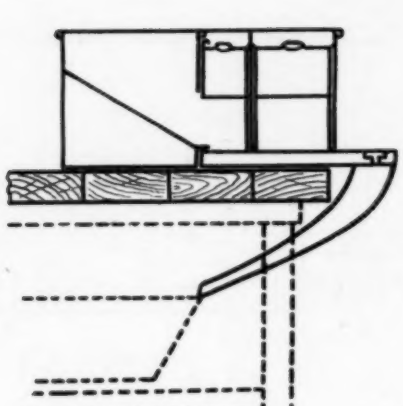


Fig. 6—Cross-section of bins, showing chute for drop delivery

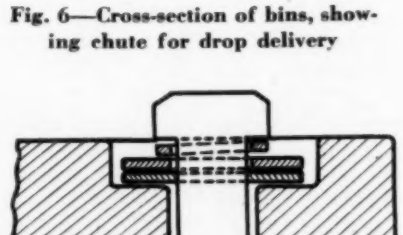


Fig. 7—Enlarged view of recess in wood fixture for assembling bolt and washers

container to her left. A more detailed description of the hand motions is shown in Fig. 2.

A simple fixture was made of wood and surrounded by metal bins of the gravity feed type as shown in Fig. 4. The bins containing the washers were arranged in duplicate so that both hands could move simultaneously, assembling washers for two bolts at the same time. As seen from Fig. 5, bins 1 contain the rubber washers, bins 2 the steel washers, bins 3 the lock washers and bin 4, located in the center of the fixture, contains the bolts. The bottoms of the bins slope toward the front at a 30-degree angle, Fig. 6, so the materials are fed out onto the fixture board by gravity as the parts are used in assembly.

Two countersunk holes or recesses were made in the front of the fixture, Fig. 7, into which the three washers fit loosely, the rubber washer on the bottom, the plain steel washer next and the lock washer on top. A small hole slightly larger than the diameter of the bolt went through the fixture as shown in Fig. 7. A metal chute was placed around the front of the wood fixture with openings to the right and the left of the two recesses so that assembled bolts and washers might be dropped into the top of this chute and carried down under the bench to a container.

In assembling the bolt and washers as the chart in Fig. 3 shows, the two hands move simultaneously toward the duplicate bins number 1, each grasps a rubber washer which rests on the wood fixture in front of the bins and slides the rubber washers into place in the two recesses in the fixture. The two hands, then, in a similar way, slide the steel washers into place on top of the rubber washers, and then the lock washers are slid into place on top of these. The hands then each grasp a bolt and slip them through the washers which are lined up so that the holes are concentric. The hole in the rubber washer is slightly smaller than the diameter of the threads on the bolt so that when it is forced through the hole it grips the bolt and thus permits the bolt with the three washers to be withdrawn vertically upward without losing the washers.

Simultaneously the two hands release the assemblies over the metal chute. As the operator begins on the next cycle with the hands in this position the second finger of each hand is in position to reach for the rubber washer which is almost at the tip of the finger.

This new method of bolt and washer assembly obeys each of the six principles of motion economy already mentioned.

1. The new method provides for the material to be located *around* the work place and close to the point of assembly.

2. The motions of the two arms are made in opposite directions on either side of the plane dividing the work place into two parts. The arms move at the same time and the motions tend to balance each other. In the old method the left hand was used as a "vise" most of the time and the right hand did nearly all of the useful work. The new method provides a fixture to do the holding and allows the two hands to move easily and smoothly together in performing the work. In assembling the bolt through the washers, the pushing is done against the fixture and not by pushing the right hand against the left as was the case in the old method.

3. The two hands complete their movements at the same instant since the work is divided so that both hands work together from the beginning to the end of the operation. This makes it unnecessary for one hand to wait for the other.

4. By providing a chute for carrying the finished assemblies to a container under the table it was not necessary for the operator to make long and unnecessary movements to dispose of the assemblies as might otherwise have been the case. Drop deliveries permit the two hands to release the finished parts at the same time thus freeing them to begin the next cycle together. It will be noted that as the two hands release the finished assembly above the chute the index and second fingers of the two hands are in the proper position for sliding the rubber washer into place in the recesses with scarcely any motion of the arms.

5. The gravity feed material bins supply the material onto the fixture board making it unnecessary for the operator to dip down into a container for material as was the case in the old method.

6. Tests conducted by means of a motion picture camera operating at a speed of 4,000 frames or exposures per minute showed that it was twice as fast to *grasp* and *slide* the washers as to *grasp* and *carry* them.

Results

The new method of bolt and washer assembly was easier for the operator to perform, it contained fewer motions and it permitted the worker to do more work in a given time than did the old method. The output under the old method was 12 pieces per min., while using the new method the operator could easily assemble 18 pieces per min. which made a 50 per cent increase in output easily possible.

EDITORIALS

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New Deal for Industry

President Roosevelt's bill for industrial revival and control coupled with a major public works program is the latest manifestation of the new deal. As a substitute for the Black thirty-hour week bill, as amended by Secretary Perkins, it is an improvement in that it permits industry to have some voice in setting reasonable limits on hours of work and minimum wages instead of attempting the impossible task of establishing the same rigid limits for different kinds of industries and for different parts of the country. Another feature that will probably speed the passage of the bill is the two-year limit written into it. Industry should be prepared, however, for an indefinite extension of this time limit. The bill is advanced as an emergency measure, and rightly so, but there is every reason to expect that some provisions will become permanent.

One very important section of the bill states that "no employee and no one seeking employment shall be required as a condition of employment to join any organization or to refrain from joining any labor organization of his own choosing." This section may be variously interpreted. On its face it says that an employee cannot be forced to join a company union, that a union member cannot be refused employment on that ground, that a man need not belong to a union to obtain employment. But the insertion of the word "labor" in the latter part of the clause throws doubt on this interpretation. Organized labor has already complained that this clause ends the closed shop, employers are likely to fear that it may mean the abolition of the open shop. The point should be cleared up before the bill is voted upon.

Space does not permit further comment on this vitally important bill here, but readers of *American Machinist* will find the industrial control section printed in full on pages 340c and d, and may expect interpretation and comment in future numbers.

Preparedness

Now that carloadings have joined steel production, automobile production, electrical energy consumption and other favorite indicators in bettering 1932 figures, even hardened skeptics are admitting that improved business is at hand. It really looks as though the extreme low levels are past and gone.

Commodity prices have jumped, shop tool and supply prices are stiffening, and forehanded business executives are placing orders while quotations are still comparatively favorable.

Most manufacturers entered the top of the tobaggan in 1929 with large inventories of shop supplies of all kinds. These had to be written off, a painful process. But now most shelves are bare, and unless anticipated, a rise in prices will bring no compensating savings on the upswing.

Shrewd buyers of industrial goods are now analyzing orders they believe to be headed their way. They are determining what will be needed to complete these orders and whether it will pay them to restore a modest stock of tools and supplies while price and delivery are in their favor.

Undoubtedly their foresight will save them money and insure against possible production delays.

Don't Underestimate All "Gyps"

Speaking before the American Management Association, Professor E. H. Schell of Massachusetts Institute of Technology pointed to the "gyp" or distress concern in every branch of business as a powerful factor in the decentralization of industry that is in progress. Some of those enterprises are distinctly of the gypsy type. Their operators have no intention of establishing a permanent business. They pay distress rents and distress wages, they buy materials where they can get a panic price, and most of them are totally unconcerned with business ethics. Opportunists, they are likely to stay put only long enough to skim the cream. Then off they go to operate similarly elsewhere.

But, as Professor Schell observes, all "gyps" are not of this type. Many of them are taking advantage of present conditions and the handicaps of the old established organizations to take business on which they can profit where the big fellow cannot. Instead of milking this business of every cent of profit they are quietly building up reserves that will stand them in good stead as conditions improve. In contrast with the confirmed nomad who made the term "gyp" appropriate these men have been accustomed to stability. Many of them have been minor executives in large companies that have had to skeletonize their forces, and they have taken with them a thorough knowledge of management methods when they lost their jobs.

It is hardly fair to call men of this type "gyps" when they start up for themselves and fight to make a living. And it is correspondingly foolish to underestimate their ability and their power as competitors. Some of them will undoubtedly be progressive factors in industry in the near future.

The Last Shall Be First

News from the steel industry has been most encouraging of late. Production has exceeded the high point of 1932 and bids fair soon to cross the 1931 line. Backlogs are building up and prices are stiffening.

There is one very significant statement in the reports printed by the steel trade journals and the newspapers —modern plants are operating at or near capacity, the obsolete ones bringing down the average to less than forty per cent.

What has been predicted by every economist and student of management has happened. The well-equipped plants are getting the business because of their greater efficiency.

Managers of metal-working plants should be warned by this example. It may not be too late to replace some of the museum pieces of equipment of which the previous generation was justly proud, but that cost so much to operate today.

• CHIPS •

President signs farm bill with inflation amendments . . . Also state emergency relief bill and Muscle Shoals bill . . . Administrators of farm bill start work, promise minimum interference with established practices . . . Congress begins consideration of drastic industry control and public works bill . . . Another cabinet member strays from the reservation . . . Secretary Ickes follows up Roosevelt's plea for price restoration by threatening to establish cement plant at Hoover Dam to beat down bid prices of cement manufacturers . . . Veterans' administration and Budget Director Lewis instructed to review reductions of veterans' compensation to avoid any hardships . . . Secretary Swanson orders cuts in Navy's land forces . . . Will close yards and skeletonize forces . . . One-third of fleet to be placed in "rotating reserve commission" . . . Some of the funds saved may be used to finance replacement of old units . . . President urges speedy ratification of amendment to end prohibition so that country may benefit from excise taxes . . . Price-fixing and production control bills for oil introduced . . . Roosevelt will ask for free hand on tariffs.

Roosevelt message to 54 world leaders brings generally favorable response . . . Hitler's speech to Reichstag far more conciliatory than expected . . . Mussolini four-power pact accepted by representatives of Great Britain, France and Germany . . . Two together may have saved disarmament conference . . . Fears aroused by Von Papen belligerency somewhat calmed but France and Great Britain take new protestations with reservations . . . France considers extension of army term by six months to strengthen frontier guard . . . Nazis order teachers to preach superiority of Nordic races . . . Complete reversion to pre-war propaganda indicated . . . After months of fighting Paraguay declares war on Bolivia . . . Then both agree to arbitration proposal . . . Japan renews attacks in North China.

R.F.C. reports acceleration in repayment of farm loans as commodity prices rise . . . Germany follows our lead in ignoring gold clause . . . Tells World Bank interest will be paid in the currencies of the respective countries making loans . . . Ford sells finance corporation to Commercial Investment Trust . . . Reichsbank directors invite Germany's private creditors to Berlin meeting for consideration of transfer moratorium . . . Senate confirms nomination of E. R. Black to succeed Eugene Meyer as head of Federal Reserve Board . . . American Tel. and Tel. continues regular common dividends.

In response to Roosevelt appeal many companies announce wage increases, some retroactive . . . American Sheet and Tin Plate and Jones & Laughlin announce installation of cold rolling mills to improve methods and reduce costs . . . Ford resumes advertising . . . A. C. Spark Plug recalls 200, has more unfilled orders than for two years . . . Briggs Body goes from three- to five-day basis . . . Pontiacs will be assembled at Chevrolet Tarrytown plant . . . Standard Oil of N. J. reduces pension age limit from 65 to 60 . . . Figures for April show unseasonal increase in employment and wages . . . Modern steel plants first to reach capacity activity as steel tide rises . . . B. & O. contracts with Lury Bros. to dispose of obsolete cars and locomotives as scrap . . . San Francisco bridge steel orders send thousands back to work at Ambridge, Gary, Worcester plants of U. S. Steel Corporation.

Western railroad presidents check freight figures and agree that recovery is really under way . . . Oil producers fight viciously and price structure crumbles . . . Automobile exports in first quarter far ahead of first three months of 1932 . . . Principal world powers sign trade armistice pact proposed by Roosevelt . . . Greyhound bus lines inauguarate package express service between New York and Chicago . . . First morning delivery within 400 miles of origin, second morning within 1,000 miles.

Despite doubling of production rate U. S. Steel backlog increased in April . . . Government reports smallest winter wheat crop since 1904 . . . Steel output continues climb but at slower rate . . . Electric power output passes 1932 figure by more than two per cent . . . Copper reaches seven cents . . . Pig iron prices rise, as do scrap prices . . . Carloadings join other indicators in surpassing 1932 records . . . Stocks fluctuate but continue on strong upward trend started at end of bank holiday.

Industrial Recovery and Control Bill Goes to Congress

Because of its vital importance to industry, Title I of the much heralded Industrial and Recovery and Control Bill, which was presented to Congress last week, is given below. This portion of the bill directly affects manufacturing industries. Title II, covering public works, and Title III, on emergency relief, though not given here, also merit close study.

TEXT OF THE BILL

A bill to encourage national industrial recovery, to foster fair competition and to provide for the construction of certain useful public works, and for other purposes.

TITLE I

Industrial recovery—
Declaration of policy.

Section 1—A national emergency productive of widespread unemployment and disorganization of industry, which burdens interstate commerce, affects the public welfare and undermines the standards of living of the American people is hereby declared to exist. It is hereby declared to be the policy of Congress to remove obstructions to the free flow of interstate commerce which tend to diminish the amount thereof, and to promote the organization of industry for the purpose of cooperative action among trade groups, to induce and maintain united action of labor and management under adequate governmental sanction and supervision, to eliminate unfair competitive practices, to reduce and relieve unemployment, to improve standards of labor and otherwise to rehabilitate industry and to conserve resources.

Administrative Practices

Sec. 2 (A) To effectuate the policy of this title, the President is hereby authorized to establish such agencies, to accept and utilize such voluntary and uncompensated-for services, to appoint, without regard to the provisions of the civil service laws, such officers and employes, and to utilize such federal officers and employes, and with the consent of the state, such state and local officers and employes, as he may find necessary. To prescribe their authorities, duties, responsibilities and tenure, without regard to the classification act of 1923, as amended, to fix the compensation of any officers and employes so appointed.

(B) The president may delegate any of his functions and powers under this title to such officers, agents and employes as he may designate or appoint, and may establish an industrial planning and research agency to aid in carrying out his functions under this title.

(C) This title shall cease to be in effect and any agencies established hereunder shall cease to exist at the expiration of two years after the date of enactment of this act, or sooner if the President shall by proclamation declare that the emergency recognized by Section 1 has ended.

Codes of Fair Competition

Sec. 3 (A) Upon the application to the President by one or more trade or industrial associations or groups, the President may approve code or codes of fair competition for the trade or industry or subdivision thereof, represented by the applicant or applicants, if the President finds (1) that such associations or groups impose no inequitable restrictions on admission to membership therein and are truly representative of such trades or industries or sub-divisions thereof, and (2) that such code or codes are not designed to promote monopolies, or to eliminate or oppress smaller enterprises and will not operate to discriminate against them, and will tend to effectuate the policy of this title. The President may, as a condition of his approval of any such code, impose such conditions (including requirements for the making of reports and the keeping of accounts) for the protection of consumers, competitors, employes and others and in furtherance of the public interest, and may provide such exceptions to the exemptions from the provisions of such code as the President in his discretion deems necessary to effectuate the policy herein declared.

(B) After the President shall have approved any such code, the provisions of such code shall be the standards of fair competition for such trade or industry or sub-division thereof; any violation of such standards in any transaction in or affecting interstate commerce shall be deemed an unfair method of competition in commerce within the meaning of the federal trade commission act, as amended. A violation of any provision of such code shall be a misdemeanor and upon conviction thereof an offender shall be fined not more than $500 for each offence.

(C) The several district courts of the United States are hereby invested with jurisdiction to prevent and restrain violations of any code of fair competition approved under this title; and it shall be the duty of the several district attorneys of the United States, in their respective districts, under the direction of the attorney-general, to institute proceedings in equity to prevent and restrain such violations.

(D) Upon his own motion, or if complaint is made to the President that abuses inimical to the public interest and contrary to the policy herein declared are prevalent in any trade or industry or subdivisions thereof, and if no code of fair competition therefor has theretofore been approved by the President, the President, after such public notice and hearing as he shall specify, may prescribe and approve a code of fair competition for such trade or industry or subdivision thereof, which shall have the same effect as a code of fair competition approved by the President under subsection (a) of this section.

Agreements and Licenses

Sec. 4 (A) The President is authorized to enter into agreements with, and to approve voluntary agreements between and among persons engaged in a trade or industry, labor organizations, and trade and industrial organizations, associations or groups, relating to any trade or industry, if, in his judgment, such agreements will aid in effectuating the policy of this title with respect to transactions in or affecting interstate commerce, and will be consistent with the requirements of clause (2) or subsection (a) of section 3 for a code of fair competition.

(B) Wherever the President after such public notice and hearing as he shall specify, shall find it essential to license business enterprises in order to make effective a code of fair competition or an agreement under this title or otherwise to effectuate the policy of this title, and shall publicly so announce, no person, after a date fixed in such announcement, shall engage in or carry on any business, in or affecting interstate commerce, specified in such announcement, unless he shall have first obtained a license issued pursuant to such

• INDUSTRIAL REVIEW •

Inquiries for machinery are considerably more numerous but orders are still hard to close. The trade feels that its turn is not going to be postponed much longer, and that the activity in the plants of its customers, as evidenced by increased employment, enlarged orders for shop supplies and materials, and repair part business, means machinery orders in the immediate future. Business was better at the beginning of May than it has been in the last fortnight.

The eastern territory as represented by reports from Boston, New York and Philadelphia has witnessed the placing of a few orders and is encouraged by the improvement in inquiries. Pittsburgh plants building mill machinery are busier but machine tool orders are still missing. Cleveland is profiting from increased automobile parts business.

Supply business in Cincinnati is better and metal-working plants other than the machine tool shops are busier. Inquiries for good used tools are strong, and inquiries for new ones are on the increase. Nothing of importance has happened in the territory centering in Indianapolis but Detroit reports strength in supplies and a few machine tool orders placed by Chrysler. Automobile activity is exceeding expectations. Chicago reports a flattening out of activity following a promising spurt the first of the month and Milwaukee tells of good repair parts business and some upturn in employment.

regulations as the President shall prescribe. The President may suspend or revoke any such license, after due notice and opportunity for hearing, for violations of the terms or conditions thereof. Any order of the President suspending or revoking any such license shall be final if in accordance with the law. Any person who, without such a license or in violation of any condition thereof, carries on any such business for which a license is so required, shall, upon conviction thereof, be fined not more than $500, or imprisoned not more than six months, or both, and each day such violation continues shall be deemed a separate offence.

Sec. 5. While this title is in effect and for 60 days thereafter, any code, agreement, or license approved, precribed or issued and in effect under this title and any action complying with the provisions thereof taken during such period, shall be exempt from the provisions of the anti-trust laws of the United States.

Limitations Upon Application

Sec. 6 (A) No trade or industrial association or group shall be eligible to receive the benefit of the provisions of this title until it files with the President a statement containing such information relating to the activities of the association or group as the President shall by regulation prescribe.

(B) The President is authorized to prescribe rules and regulations designed to insure that any organization availing itself of the benefits of this title shall be truly representative of the trade or industry or subdivision thereof represented by such organization. Any organization violating any such rule or regulation shall cease to be entitled to the benefits of this title.

(C) Upon the request of the President the federal trade commission shall make such investigations as may be necessary to enable the President to carry out the provisions of this title, and for such purposes the commission shall have all the powers vested in it with respect to investigations under the federal trade commission act, as amended.

Sec. 7 (A) Every code of fair competition, agreement and license approved, prescribed or issued under this title shall contain the following conditions: (1) That employes shall have the right to organize and bargain collectively through representatives of their own choosing; (2) that no employe and no one seeking employment shall be required as a condition of employment to join any organization or to refrain from joining a labor organization of his own choosing, and (3) that employers shall comply with the maximum hours of labor, minimum rates of pay and other working conditions approved or prescribed by the President.

(B) The President shall, so far as practicable, afford every opportunity to employers and employes in any trade or industry or subdivision thereof with respect to which the conditions referred to in clauses (1) and (2) of subsection (a) prevail, to establish by mutual agreement, the standards as to the maximum hours of labor, minimum rates of pay, and such other working conditions as may be necessary in such trade or industry or subdivision thereof to effectuate the policy of this title; and the standards established in such agreements, when approved by the President, shall have the same effect as a code of fair competition, approved by the President under subsection (a) of section 3.

President May Prescribe

(C) Where no such mutual agreement has been approved by the President he may investigate the labor practices, policies, wages, hours of labor, and working conditions in such trade or industry or subdivision thereof; and upon the basis of such investigations, and after such hearings as the President finds advisable, he is authorized to prescribe a limited code of fair competition, fixing such maximum hours of labor, minimum rates of pay, and other working conditions in the trade or industry or subdivision thereof, investigations as he finds to be necessary to effectuate the policy of this title, which shall have the same effect as a code of fair competition approved by the President under subsection (a) of section 3. The President may differentiate according to experience and skill of the employes affected and according to the locality of employment; but no attempt shall be made to introduce any classification according to the nature of the work involved which might tend to set a maximum as well as a minimum wage.

(D) As used in this title the term "person" includes any individual, partnership, association, trust or corporation.

Rules and Regulations

Sec. 9 (A) The President is authorized to prescribe such rules and regulations as may be necessary to carry out the purposes of this title, and fees for licenses and for filing codes of fair competition, and any violation of any such rule or regulation shall be punishable by fine of not to exceed $500 or imprisonment for not to exceed six months, or both.

(B) The President may from time to time cancel or modify any order, approval, license, rule or regulation issued under this title, and each agreement, code of fair competition, or license approved, prescribed, or issued under this title shall contain an expressed provision to that effect.

Two Aeronautical Medals Awarded

For "notable achievement in the advancement of aeronautics," the Daniel Guggenheim Medal for 1933 was awarded to Commander Jerome Clarke Hunsaker, vice-president of the Goodyear Zeppelin Corp. The formal presentation of the medal will probably take place at a meeting of the Society of Automotive Engineers in Chicago late in August.

Orville Wright was conferred the Franklin Medal at the Medal Day exercises of the Franklin Institute in Philadelphia on May 17. This was in recognition of valuable investigations by Mr. Wright and his brother from which they developed their airplane.

Commander Hunsaker, a graduate of the Naval Academy, received degrees of Master of science and Doctor of Engineering from the Massachusetts Institute of Technology where he was an instructor from 1914 to 1916. While in charge of the Aircraft Division Bureau of Construction and Repair of the Navy Department, he had the responsibility for the naval aircraft war program.

Commander Hunsaker designed the first modern non-rigid airship, produced in the United States, as well as the Shenandoah. With Gilmore, Westervelt, and Richardson, he designed the N-C flying boats. He was chief of the Design Division, Bureau of Aeronautics from 1921 to 1923. In 1927, he resigned as Commander, Construction Corps, U. S. Navy. Commander Hunsaker is the author of many professional papers, a member of the American Society of Naval Architects and Marine Engineers.

Free Entry Applications in Britain

London, England—According to the 1932 report, recently issued by the Machine Tool Trades Association, there were 666 applications for free entry of machine tools before the Machine Tool Advisory Committee during the year. This committee aids the Import Duties Advisory Committee in reaching decisions.

A considerable portion of these applications were for the importation of special machines for new industries which are being set-up in England, notable cases being the watchmaking and optical instruments industries. A large number of applications were also received for small machines and parts of machines which could hardly be classed under what are understood to be machine tools.

Tariff Powers Urged by Mooney

Pointing out that in 1928 foreign trade provided employment for 2,400,000 American families, J. D. Mooney, president of General Motors Export Co. and of the American Manufacturers Export Association, state that power should be vested in President Roosevelt to negotiate reciprocal tariff treaties. The occasion was the Two-Way Trade dinner in New York on May 17, sponsored by the World Trade League of the U. S.

Other speakers recommended stabilization of international exchanges on a gold basis and the removal of existing exchange embargoes. Confidence was expressed that the United States would take part in a world trade revival.

Moss Honored for Welding Research

H. H. Moss, of the Linde Air Products Co., was awarded the Samuel Wylie Miller Memorial Medal at the annual meeting of the American Welding Society on April 27, "for his achievements in the application of fusion welding and oxy-acetylene flame cutting." This medal is an annual A.W.S. award presented for meritorious contributions to the science and art of welding.

In 1931, Mr. Moss's aid to the Committee on Technical Developments under President Hoover's Conference on Home Building and Home Ownership culminated in the presentation of the use of welding in small house construction before the conference. More recently, he has been studying the use of an oxy-acetylene flame in cutting, boring and shaping metal parts in a way similar to machine tool operations.

Preliminary results of these investigations were presented before the A.W.S. in 1932 at its Fall Convention in Buffalo, N. Y., and were reported in this paper under the title "Machining with Oxy-acetylene" (*AM*—Vol. 76, page 1217).

Two New Standards Offered to Industry

The Simplified Practice Division, Bureau of Standards, is now submitting to industry for comment and approval two revisions of existing standards: R-67 on tapered roller bearings, and R-36 on milling cutters. The revision of the standard on bearings extends the scope of the revised standard adopted by the Society of Automotive Engineers in January, 1932, to include sizes up to 12-in. bore and certain steep angle bearings for naval and general industrial use.

April Orders for Machine Tools

	Index A	Index B	Index C	Total
Number of reports	25	23	22	70
Class bases	$2,541,127	$578,120	$134,119	$3,253,366
Gross orders for the month	16.3	14.1	22.2	16.2
Cancellations	0.1	1.7	0	0.4
Net orders	16.2	12.4	22.2	15.8
Shipments	19.0	20.3	30.3	19.7
Unfilled orders	23.5	33.1	64.1	26.9
Three months' average of gross orders	15.0	12.8	23.8	14.9

Base — Average shipments for years 1922-24.
Index A — Base more than $50,000.
Index B — Base $10,000 to $50,000.
Index C — Base less than $10,000.

Machine Tool Index Rises

An increase of 2.8 points in the index of gross orders, as reported by the National Machine Tool Builders' Association, represents a normal recovery from the abnormally low levels reached during the banking holidays rather than a reflection of increased activity in other fields. However, indications are that the downward trend has been reversed and that improvement is in prospect upon passage of appropriation bills in Washington that will put men to work.

The distribution of orders for April was better than for the preceding month although there were still 24 out of 70 firms that reported less than 10 per cent of their base and 17 reported no orders at all. The three months' average reached a new low at 14.9 as against 20.1 for March which was caused by the dropping of January's relatively high index of 31.6. Unfilled orders and shipments also reached new low levels with indexes of 26.9 and 19.7 respectively.

Federal-State Employment Service Advocated

Miss Perkins, Secretary of Labor, is strong for the free employment office system that will eventually be set up under the Wagner bill now awaiting Senate action. The bill provides that the state and federal government will share equally the cost of the placement agencies. This means of matching men to jobs is considered by Miss Perkins to be an essential part of the industrial control and industrial works program in order to build purchasing power. The Labor Department will act as a coordinating agent.

New York State is now being used on a case study principally because there the government is well organized to investigate industrial alignments and because it is ground with which Miss Perkins is familiar. However, the Labor Department will not insist upon a uniform pattern for all 48 states.

Meanwhile thorough overhauling of Labor Department routine activities has been deferred in the face of the urgency of remedial legislation. At the request of Miss Perkins, a committee of the American Statistical Association will submit a report two or three months hence suggesting how the statistical services should be modified.

Foster to Represent Machine Industry on Arbitration Council

Pell W. Foster, Jr., has been appointed representative of the electrical and general machinery industry on the Business Advisory Council of the American Arbitration Association. This council, composed of outstanding representatives from approximately 30 industries, will attempt to coordinate and develop the use of arbitration as an aid to revival of trade.

A survey of each industry will be made to determine to what extent arbitration is now being used, whether adoption of standardized clauses is practicable and whether rules of procedure can be developed to correct existing abuses and injurious practices. Five such surveys, including that of the electrical manufacturing industry, have already been completed.

Alfred Herbert Executive Dies

S. H. March, for the past nine years export manager for Alfred Herbert Ltd., Coventry, England, manufacturer, importer and exporter of machine tools and small tools, died May 5. Mr. March was well known in the machine tool industry in the United States which he visted many times, and he was also well known on the Continent. He commenced his business career as an apprentice to the Birmingham Small Arms

Co., and afterwards joined the sales staff of Charles Churchill & Co., London. On the formation of Churchill Machine Tool Co., he was appointed director and general manager and also acted as vice-chairman of the Associated British Machine Tool Makers. In 1924 he joined the Alfred Herbert Ltd., as a member of the executive staff. He was a member of the Council of the Machine Tool Trades Association and was recently appointed to a committee to assist the Import Duties Advisory Committee.

• BUSINESS ITEMS •

Peabody Engineering Corp., New York, N. Y., manufacturer of combustion accessories for industrial plants, has taen a lease on the Emery factory at Glenbrook, Conn. Machinery is being installed, and it is understood that operations will begin this month.

The Middletown (Conn.) Mfg. Co. has organized and started operations in a part of the plant formerly occupied by the Westinghouse Electric & Mfg. Co. The company manufactures automobile accessories.

The Dunbar-Gibson Co., Bristol, Conn., has been organized as a subsidiary of the Wallace Barnes Co., Bristol, and will manufacture metal specialties.

The Brookhill Mfg. Co., Danielson, Conn., manufacturer of buffing wheels, has secured a larger and more modern factory in Brooklyn, N. Y., and is transferring its business to that city.

The Bard Parker Co., manufacturer of surgical instruments, with plants at Croton Falls, N. Y., Erie, Pa., and Cleveland, Ohio, will move all plants to Danbury, Conn., the New York plant to be transferred first.

• PERSONALS •

Ralph W. Hurlburt has been elected secretary-comptroller of Peck, Stow & Wilcox Co., New Britain, Conn., to succeed Arthur G. Potter, resigned. Otto J. Blank has resigned as vice-president and factory manager. Edward G. Hackbarth was named assistant to the president, and Adolph J. Trapp was made superintendent.

Henry E. Hund resigned recently as vice-president and general manager of the Briggs Mfg. Co., Detroit, Mich.

Joseph E. Otis, Jr., vice-president and general manager of the Alemite Corp., Chicago, has been elected to the same position with the Stewart-Warner Corp., and its subsidiaries, which includes the Alemite Corp.

• OBITUARIES •

Joseph William Bettendorf, president of the Bettendorf Steel Car Co., manufacturer of railroad cars, died May 16 at the age of 68. In 1886 Mr. Bettendorf joined the late W. P. Bettendorf, who had already organized the Bettendorf Metal Wheel Co., then manufacturing steel wagon axles. The business grew until it included steel wagons, railway car frames and finally complete cars. In 1903 the plant was moved to Bettendorf, Iowa, and Joseph Bettendorf became president in 1910. He was also president of the Buddy "L" Mfg. Co., maker of steel wagons and miniature trucks for children, the Westco Pump Co., the Micro Machine Co., and the Zimmerman Steel Co.

Herman Dock, well-known designing engineer, died at his home in Guadalajara, Mexico, on April 6. Mr. Dock was formerly superintendent of the old New York Steam Engine Co.'s plant at Hope, R. I., where he built engines for marine and government work. Six of these engines had a novel upper end on the connecting rod which eliminated the use of a piston pin. To machinists he was best known by the Rivett-Dock threading tool for engine lathe work, but his inventive genius ran largely to variable-speed transmissions and internal combustion engines. Mr. Dock retired to Guadalajara several years ago.

William H. Hassenpflug, formerly vice-president of the Harnischfeger Corp., Milwaukee, died May 8 at the age of 69. His first experience with the machinery industry was with William Sellers & Co., Inc., of Philadelphia, but in 1900 he went to Milwaukee to join the Pawling & Harnischfeger Co.

Frank W. Bunn, plant manager of John A. Roebling's Sons Co., Trenton, N. J., passed away this month at the age of 68. Mr. Bunn had been connected with company for 27 years.

Frank M. Farber, president of the Marshalltown Mfg. Co., Marshalltown, Iowa, maker of shearing machinery, died at the age of 61.

William J. Perkins, 49, president of the Perkins Machinery Co., Milwaukee, manufacturer of mining machinery, died May 2.

David A. Shaw, general manager of the Monmouth Products Co., Cleveland, Ohio, manufacturer of auto parts, died at the age of 67. He was connected with the Monmouth company since 1922. Previously Mr. Shaw was president of the Simplex Motor Co., Mishawaka, Ind., and in 1915 became president of the Grant Motor Co.

Otto Albrecht, formerly with the Bement-Niles Co., and later with the Tindel-Morris Co., died May 21, aged 94.

H. H. Cutler, 73, who founded the Cutler Hammer Co., in 1893, and who was an official until 1917, died May 20. He held many patents on electric controls and gas engines.

• MEETINGS •

American Foundrymen's Association. Annual convention and foundry and industrial exposition. June 20-23. Stevens Hotel, Chicago. C. E. Hoyt, executive secretary, 222 West Adams St., Chicago, Ill.

American Iron and Steel Institute. Forty-second general meeting. May 25. Hotel Commodore, New York. George H. Charls, secretary, 350 Fifth Ave., New York, N. Y.

American Society of Mechanical Engineers. Second national lubrication engineering meeting. May 25-26. Pennsylvania State College. Prof. F. G. Hechler, chairman, Pennsylvania State College, State College, Pa.

National Metal Trades Association. Thirty-fifth annual convention, June 8. Annual meeting of administrative council, June 7. Congress Hotel, Chicago. J. E. Hynan, national secretary, Peoples Gas Bldg., Chicago.

Meetings During Engineering Week Chicago World's Fair

American Society of Mechanical Engineers. Semi-annual meeting. June 25-30. Stevens Hotel, Chicago. Calvin W. Rice, secretary, 29 West 39th St., New York, N. Y.

American Society for Testing Materials. Annual meeting. June 26-30. Stevens Hotel, Chicago. C. L. Warwick, secretary, 1315 Spruce St., Philadelphia, Pa.

Midwest Engineering & Power Exposition. June 25-30. Coliseum, Chicago. Headquarters, 308 West Washington St., Chicago, Ill.

Society of Industrial Engineers. Annual meeting. June 27-30. Stevens Hotel, Chicago. George C. Dent, secretary, 205 West Wacker Drive, Chicago.

A Better Shop

"Say, Ed, when are you coming over to our new shop? I keep on inviting you, and you keep on stalling."

"I know, Al, but I'm foreman, assistant, clerk and sweeper now, not to mention tool crib attendant and oiler. My staff has been cut so low and I have to look after so many things that I don't have much spare time."

"Well, make it as soon as you can. I want to have a good long talk with you."

"What's the matter with telling me now?"

"None, but we've only got about forty minutes, and if we start arguing, as we usually do, we won't get anywhere in forty minutes. I don't want an argument. I want constructive advice."

"That's quite a change on your part. Usually you'd rather give me advice that I don't want than take advice that you need."

"I wouldn't say that, Ed. Of course, I don't take all the advice you offer, and what I do, I don't take literally. It would show weakness on my part if I did, but I turn over in my mind the advice you give, sometimes use it in part, and sometimes do the opposite. Discussion stimulates thought and begets logical reasoning, and you usually bring out some point that I overlooked."

"What kind of trouble are you in now? I thought everything was going slick?"

"It is. That's why I want your help. I might as well tell you what it is so that you can be thinking it over. Briefly, what's on my mind is this. We are a new firm with a product that is radically new in design. Both Mason and myself have worked up from the bench and know the troubles of mechanic and foreman. Personally, I have never worked in a place where some of the men were not dissatisified, and all of them kicking about something."

"Neither have I, but that's usually the nature of the beast."

"Maybe it is, but Mason and I would like to run our shop under ideal working conditions. We'd like to give our few men some advantage, privilege or condition that they can get nowhere else."

"Why don't you double their pay, or cut their hours—something like that?"

"That isn't the answer. I don't know that there is any answer, but I have in mind to do something that will give our men a genuine interest in their work and in the firm."

"Yeah, I've heard that line before. I call it hot air; but you put it up to your men, and I'll bet they call it boloney!"

"I know all that, Ed, but I'm not trying to get something for nothing. We really want to help our men without patronizing them."

"Ah, I think you struck the keynote, Al. The newly-rich like to give big parties, to show their appreciation—so they say and think—but really to patronize those who are socially or financially inferior and to advertise themselves to those who are their social superiors. You have the same itch, Al, but haven't stopped to analyze it."

"You're wrong, Ed. We certainly don't want to be patronizing or paternal. We have seen the results of that policy."

"I don't need to waste any time thinking over your problems. Either you and Mason are getting socialistic or you're merely slopping over. My guess is the latter."

"I told you we'd start arguing and get nowhere."

"No, and you won't get anywhere with that idea, either."

Is there anything that Al can do for his men that will be to their benefit and not disrupt discipline or cause discontent in other shops?

Discussion

Is Talk Cheap?

If Al is the busy man he claims to be, it will soon be apparent to the average salesman who is quick to detect whether a business man is capable of judging a proposition directly or indirectly. Salesmen know very well that long talks only bore busy men of decisive character and that they are likely to lose a sale if they do not make an impression quickly. They also know that men who are slow to decide have to be approached differently.

It will always be to Al's interest to find out what a salesman is offering; and if it is not likely to be of any advantage to his business, the quicker the discussion is courteously, but firmly, closed the better. On the other hand, if something apears good and requires more time for consideration than he can at present afford, he should be frank about it and say so. As soon as the average salesman is told in a straightforward manner that he has made a good impression, he will soon stop useless talk and make any further proposition in such a way as will save not only Al's time but his own. Al, therefore, has no one but himself to blame if he wastes his time. —L. Brown.

Renovizing

Assemblers must of necessity use many different sizes, kinds and types of tools. One size wrench might be used the first thing in the morning and dropped where last handled. During the day, with all the extra parts and rubbish, it generally becomes buried, and if needed in the afternoon, a half hour is spent looking for it.

Having one man's tools (not those generally kept in his own tool box but company's wrenches of all types) painted one color, the assembler can spot them easily wherever they may be. These tools are not kept in a drawer or thrown in a pile on or under a bench but hung on a board which is looked after solely by this one assembler. This board has the same general appearance one finds in a well kept power plant. The shape of the tool is painted on the board where it is supposed to be hung.

At the completion of the day's work each man can place all these tools on his board, and in one glance can see what is lacking and from the color spot his lost tool easily. —H. L. Scherer,
Pullmore Division,
Rockford Drilling Machine Company.

Al is not at all too fussy in being so careful about the arrangement of the new plant. He is showing sound judgment and good business acumen in having everything completely ready before he moves in.

Placing a maple floor in the assembly room, arranging the best lighting effects, making the wall a light shade are important and at the present time will cost a minimum. However, should Al move in and begin work, the cost of having this done would be almost double its present amount. He would then have to bother with his machinery already installed and in the way. While painting was going on, and the floor being put in the assembly room, he would be entirely handicapped and unable to do any work at all perhaps at a time when he would need the plant most.

The manner in which Al is going about this new venture will win many new friends for him. Everyone can take care of the larger matters—it is attention to details which attract the eye of the customers. As to machinery, it is evident that Al has all the essential equipment—plenty to get along with.

—Will Herman,
Tanenbaum & Son Oil Company.

Production Control

Did you ever wait to buy doughnuts as they were fried, jealously guarding your turn to be sure no one gets ahead of you? Whether you are producing drilling machines or doughnuts, the problem of production control and of satisfying the customer is bound to exist, even if only in the mind of the girl who notes the arrival of customers as she turns the doughnuts.

The foreman of the small shop will find the problem beginning to get complicated when the product varies in size or kind or when parts are assembled. He will do well to devise some method for handling details without trusting to memory, not aping the large systems with complicated forms, but with a simple arrangement suited to his needs. It may be no more than a single schedule sheet with delivery dates. If he is acquainted with the principles used in large plants, he can foresee what he will need as his business increases and so arrange his primary system as to make for easy transition.

—Harrison G. Brown,
Supervisor of Standards
Crompton & Knowles Loom Works

Though an elaborate production control system may be necessary for a large plant, it does not follow that such a system would be practicable for a small one such as that of Al and Mason. For such a plant, it is possible that Al himself may at first, as he supervises the work from day to day, exercise all the production control necessary. When he finds himself unable to do so, he could

then adopt a simple system which would not take much time or expense and yet be adaptable to his needs. There are two extremes to be avoided; one is the danger of delaying too long to put a system into effect, and the other is the danger of putting in a system that is not needed and which may become a greater hindrance than a help.

—L. Brown.

Follow the Leader

From the strictly conservative viewpoint, Al is quite justified in paying the prevailing rate of wages in his locality, no more, no less. But if he expects to attract a better grade of worker, the strictly conservative viewpoint must be discarded for a more liberal one.

I have in mind two small shops. The first one seems to be run with the profit motive paramount at all times. When hard times come, this concern is first to reduce wages or lay off employees, abruptly and without the least consideration. As a consequence, the better grade of mechanic gives it a wide berth and labor turnover is high.

The second establishment is more humanely conducted. Working conditions are better, a few cents per hour above the standard rate is the rule, rather than the exception, and, in general, the very atmosphere of the place breathes a spirit of "live and let live." Labor turnover is low, and the standard of workmanship high. The margin of profit compares favorably with that of competing concerns, including the first-named shop.

In setting a precedent of better wages and conditions, Al will be subject to the gloomy prophecies and petty annoyances which always accompany this type of pioneering, but he will find that his reward will be worthwhile, not only in a financial sense, but in the respect of his business associates and in the goodwill of loyal employees.

—Robert S. Alexander.

High Finance

Ed is entirely justified in watching his step. Al's good intentions would hardly be sufficient balm to soothe his disappointment if he hurried into something which later developed into failure.

So far as their little argument about selling or buying at par, or at less than par is concerned, both of them seem a little hazy with the same brand of haziness that has made many an investor an easy mark. So far as the actual and true value of common stock is concerned, the term "par value" means just exactly nothing.

The entire proposition, of course, resolves itself into the simple question as to whether the tangible property, business and good-will really constitute sufficient security to justify investing. Al's statement that "our good-will value is around $10,000," regardless of how firmly he may believe it, should be received with caution.

Unless Al has a separate nest-egg laid away somewhere, I fail to see how he figures that he would be able to buy back this stock in case of financial trouble. If he wants to asume all of the risk, the nearest he could come to it would be to issue the $5,000 in stock, which he hopes to sell to friends, in the form of preferred stock and the balance, kept by Mason and himself, in common stock. Then, it could be written into the preferred stock certificates that a given dividend is to be paid upon them each year before any dividend is paid on common stocks. —John E. Hyler.

American Machinist
REFERENCE BOOK SHEET

Grinding, Polishing and Buffing of Monel Metal and Pure Nickel

ANY EFFECT from a sandblast finish to a highly lustrous mirror finish may be obtained on monel metal and pure nickel. The layout of the necessary operations depends upon three considerations: the character of the work to be polished; the desired finish; and the polishing equipment. A base from which all surface defects have been removed must first be produced. The number of operations required depends on the coarseness of the first wheel applied. The pressure must be closely watched, as excessive heat will destroy the true color of the buffed metal and will be likely to warp flat, light gage articles. Care is especially important in grinding down welds, which might crack. Light welds can be ground with a No. 36 grit, rubber-bond wheel; heavy welds, No. 24 grit. Straight wheels, 6 in. in diameter by 1 in. face, and driven by a portable grinder, are used for the general run of weld grinding. Rubber-bond wheels are operated at approximately 8,000 to 9,000 surface ft. per min.

POLISHING—Wheels for "roughing" and "dry fining" should be spirally machine-sewed wheels of tightly woven unbleached cotton fabric. The wheels are made up of sections approximately ¼ in. thick. A soft or cushioned face is obtained by gluing the sections only to within ½ to 3 in. of the periphery. Fine-grit wheels require more cushion than coarse wheels. For the "greasing" operation, a more resilient and flexible wheel is necessary. A suitable wheel is made of 64-68 count unbleached sheeting, with more cushion than required for coarser polishing. Grease coloring may be done on a full disk quilted sheepskin wheel, or a spirally sewed wheel made from fine count (88-88) heavy sheeting. Bobbing done with an emery grout is more on the order of a burnishing operation than a polishing operation, and if done in one operation, the best wheel is a walrus leather type. If two bobbing operations are used the second should be done with a medium-density felt wheel. The best efficiency is obtained from emery rolled head wheels at 6,500 to 7,500 ft. per min.

BUFFING — This operation is frequently divided into two operations—"cutting down" and "coloring." The former is done with tripoli. Some polishers prefer a wheel of the same sewing and fabric as recommended for grease coloring, but with loose sections, whereas others like a full disk wheel fabricated from high count sheeting, the only sewing being around the arbor hole and one or two rows of sewing midway between the arbor hole and the periphery. The coloring operation used for developing a mirror finish is best obtained with a loose disk canton flannel wheel at a surface speed of 10,000 ft. per min. Cutting down with spiral sewed buffs should be done at a surface speed of 8,000 to 9,000 ft. per min. Less pressure is used than for polishing.

BRUSHING—As a final operation brushing produces a smooth even finish, blending in the wheel marks of the previous polishing wheel. When used with emery cake, the tampico brush wheel leaves the surface ideal for buffing, and is supplanting the old bobbing operation when developing a mirror finish. If the grease wheel is well broken in, however, the tampico operation can be avoided. A tampico wheel used with emery paste is also employed as a final operation to produce a satin or scratch brush finish; with pumice and water, or pumice and oil, for a butler finish. Wire brushes do not remove deep scratches or blemishes. Instead, they perform more of a peening operation similar to a very fine sandblast, but resulting in a brighter finish than sandblasting. Wire brushes are only used in sheet metal finishing as a final operation for producing a satin finish. Monel metal wire should be used in wire brushes for finishing monel metal or pure nickel, since small particles of metal from the wire wheels are certain to be embedded in the metal being finished. All brush work is done at slower speeds than polishing operations. The range of brushing speeds is from 3,000 to 6,000 ft. per min. Bright wire brush finish requires a fine wire brush (0.004-0.008 in. diameter wire) operated at about 4,000 to 6,000 surface ft. per min. If a matte finish is desired, heavier wire and slower speeds are used.

MILL FINISHES—Monel metal and pure nickel may be obtained in cold-rolled or full-finished sheets. Cold-rolled sheets are furnished with either regular cold-rolled finish, or No. 5 mirror finish which reflects a sharp image. Full-finished sheets are furnished in the "as-rolled" condition, which has been annealed, pickled, and given four to six cold passes. It is also furnished in the No. 8 finish of lustrous satin characteristics.

POLISHING COLD-ROLLED SHEETS—Where cold-rolled sheets are used for cabinet work, the surface can usually be polished in a short series of operations. In many cases it is only necessary to buff with tripoli, and then bring out the bright lustrous color with an aluminum oxide (white) or chrome oxide (green) buffing compound. Where it is desired to develop the best possible finish, it is advisable to start the operation by "grease-coloring" with fine emery cake (7) (see chart), and follow with "cutting down" with tripoli (10). In some cases tripoli can be charged on the same wheel with emery paste. The last is a coloring operation (11 or 12). Pieces that show handling scratches or tool marks should first be cut down locally with emery paper or emery wheels and then polished step by step until prepared for the grease coloring or cutting down operation that covers the entire area of the piece.

POLISHING FULL-FINISHED SHEETS—The device, well known to polishers, of

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REFERENCE BOOK SHEET

Grinding, Polishing and Buffing of Monel Metal and Pure Nickel

"crossing" the direction of grinding as each finer grit is started enables the operator to judge when the earlier marks have been cut away. If these marks are not removed early in the grinding operation, they will show up later when buffing is started and require retracing the series of operations. The sequence of operations follows:

180 emery, dry ..... (5)
180 grease wheel ..... (5)
200 or 220 grease wheel ..... (6)
Buff with tripoli ..... (10)
Color ..... (11) or (12)
Clean with whiting ..... (16)

Sometimes it is helpful to use a tampico brush with fine emery cake (8), followed by the final polishing operation.

FINISHING DEEP-DRAWN ARTICLES—The operations are for shells that carry a certain amount of die scratching:

120 emery, dry ..... (3)
150 grease wheel ..... (4)
180 grease wheel ..... (5)
Buff with tripoli ..... (10)
Color with white finish ..... (11)
Clean with whiting ..... (16)

Another method which gives better results at slightly longer time is the following:

Polish on 150 dry wheel ..... (4)
Polish on 180 grease wheel ... (5)
Polish on 200 sheepskin wheel.. (6)
Brush on tampico wheel ..... (8)
Buff with tripoli ..... (10)
Color with white finish ..... (11)
Clean with whiting ..... (16)

FINISHING WELDED EQUIPMENT MADE FROM FULL-FINISHED SHEETS—The following operations are suggested for finishing light gage welded equipment, such as used in hotels, hospitals and canneries, where finish is important:

Grind weld ..... (1)
80 emery, dry ..... (2)
(over welded area)
120 emery, dry ..... (3)
180 emery, dry ..... (5)
180 emery, grease ..... (5)
Brush with tampico and emery cake ..... (8)
Buff ..... (11)
(if bright finish is specified)
Clean with whiting ..... (16)

If only a commercial finish is required, the procedure may be stopped after the third operation. To develop a fine scratch finish, however, follow the cycle as shown above, omitting the buffing operation. For No. 8 satin-finished sheets, after the No. 180 emery grease, buff lightly, and blend in by hand, using No. 200 worn emery cloth dipped in oil. Rub in the same direction as scratches in the parent metal. Finally, clean with whiting.

POLISHING CASTINGS—After the casting is brought to a reasonably smooth contour, it is polished by using the following operations:

80 emery, dry ..... (2)
120 emery, dry ..... (3)
150 emery, dry ..... (4)
150 emery, grease ..... (4)
Tripoli buff ..... (10)
White finish buff ..... (11)

After the fine emery in grease, the use of a Tampico brush wheel with a fine grade of emery cake often permits saving of time on the tripoli buff. Sandblasting or wire brushing is frequently used to brighten recessed areas.

— GRINDING — POLISHING — BUFFING — MONEL METAL and PURE NICKEL —

GENERAL TERMS	NAME OF OPERATION	NO. OF OPERATION	GRIT	ARTIFICIAL ABRASIVE	TURKISH EMERY	WHEELS	DRY	TALLOW OR EMERY GREASE CAKE	COMPOUND	SPEED Surface Feet per Minute	FINISH
Grinding		1	#24 #36	X		Rubber Bound Grinding Wheel	X			8000 to 9000	
POLISHING	Roughing	2	#60 #80	X		Cotton Fabric Sewed Sections. Sections Glued Together To Give Desired Width - Soft Cushion Face.	X			6000 to 7500	Rough Grind
POLISHING	Dry Fining	3	#100 #120	X			X			Do.	Commercial Grind
POLISHING	Greasing	4	#150		X	64-68 Unbleached Sheeting, Spiral Sewing Sections Glued Together To Give Desired Width - Softer Cushion Face Than Needed For "Roughing" or "Dry Fining."		X	Polishing Tallow or #180 Emery Grease Cake	Do.	Fine Grind
POLISHING	Greasing	5	#180		X			X	Do.	Do.	Fine Grind
POLISHING	Grease Coloring	6	#200 #220		X	88-88 Unbleached Sheeting - Same Construction As For Operations #4 & #5 - or - Quilted Sheep Skin Wheel		X	Polishing Tallow or "F" Emery Grease Cake	Do.	Fine Scratch Finish
POLISHING	Grease Coloring	7				88-88 Unbleached Sheeting - Loose Spiral Sewed Sections or - Loose Disc Wheel.			"F" Emery Grease Cake	Do.	Fine Scratch Finish
Brushing		8				Tampico Wheels			"F" Emery Grease Cake or "Grout"	3000 to 6000	Scratch Brush or Satin
Bobbing or Sanding		9				Walrus Leather Wheel. When Two Operations Required, Second Usually With Medium Density Felt Wheel			"Grout"	5000	
BUFFING	Cutting-Down	10				Same As Operation #7			Tripoli	8000 to 9000	Bright
BUFFING	Coloring	11				Do.			Aluminum Oxide Buffing Compound (White)	10,000	Bright
BUFFING	Coloring	12				Loose Disc Buff - or - 88-88 Unbleached Sheeting - or - Canton Flannel.			Chromium Oxide Buffing Compound (Green)	10,000	Mirror
SPECIAL FINISHES	"Lea" Method	13				Same As Operation #7			Lea Compound "N"	5500	Scratch Brush or Satin
SPECIAL FINISHES	Wire Brush	14				Monel Metal Wire Brushes			Soap Bark Solution or Water	4000 to 6000	Wire Brush or Satin
SPECIAL FINISHES	Bobbing	15				Walrus Leather Wheel			Pumice With Oil	5000	Butler or Satin
Cleaning		16				Canton Flannel Cloth (Hand Operation)			Venetian Lime (Whiting)		

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• NEW BOOKS •

PROFIT ENGINEERING. *By C. E. Knoeppel, with foreword by F. W. Shibley and supplementary chapters by A. J. Minor and E. St. Elmo Lewis. 326 pages, 6x9 in. Bound in cloth boards Illustrated by charts and diagrams. Published by McGraw-Hill Book Company, Inc., New York and London. Price $3.*

Mr. Knoeppel's book is built around his "Profitgraph" which he first used in 1909 for charting the profit course of a business. He emphasizes continually the vital need of conducting business at a profit if the business is to survive, a fact that has been overlooked or ignored by so many managers if we may judge from the wrecks that clutter the path of industry and trade. His approach is essentially an engineering one, and therefore intelligible to readers of *American Machinist*.

As Mr. Shibley says in his foreword, Mr. Knoeppel sums up his philosophy of business in this paragraph:

The broad premise of this presentation, then, is that the public does not exist for business, but that business exists for the public; that business is a service mechanism; that service at a profit, not profit alone, is the keystone in the business structure; that profit should be adequate and regular, in the same way that wages and salaries should be continuous and as high as possible; that all costs are costs of distribution; that an economic price is one that is fair to all parties concerned; that profits should be planned in advance and controlled much as is production in our plants; and that it is the province of profit engineering to bring about this desirable and necessary result.

Mr. Minor's chapter deals with the mathematics behind the "Profitgraph," while Mr. Lewis discusses how to secure the sales called for by it.

GEAR DRIVES BASED ON SPEED STANDARDIZATION. *By Dr. Ing. R. Germar, with preface by Dr. Ing. G. Schlesinger, professor at the Technische Hochschule, Berlin. From a review by J. I. Hommel, standards engineer, Westinghouse Electric & Mfg. Co. 62 pages, 32 illustrations and 31 tables. Text in German. Published by Julius Springer, Berlin. Price, 9.60 marks.*

This new method of figuring gear drives was given impetus by Professor Schlesinger's work on machine tool speeds. It extends the idea of speed standardization by preferred numbers to the calculation of gear drives, and enables the designer to select quickly the simplest way of changing existing tools to the new speed standards, and also to select the most efficient drives where entirely new work is being considered. Theoretical considerations are expressed in simple formulas and are amplified by readily usable tables for reading off the required diameters and number of teeth. An explanation is given for plotting more difficult gear combinations on plain cross-section paper. Special attention is paid to drives where one or more gears are in permanent mesh and where the engagement is obtained by sliding clutches or similar devices.

INFLATION. *By Donald R. Woodward and Marc A. Rose. 165 pages, 5x7½ in. Illustrated by charts. Bound in cloth boards. Published by Whittlesey House, McGraw-Hill Book Company, Inc. New York and London. Price $1.50.*

Guaranteed to give any layman, and a good many of the experts, a clearer picture of what inflation means, what its history has been, why it is essential now, and why we must be very certain that it does not run away with us in the future. Expressed in simple language and devoid of personal bias except in the last chapter in which the authors express their confidence in the desirability and workability of the substitution of a managed currency for our traditional gold-base dollar. Worth an hour and a half of anyone's time.

Methods of Driving Straight-Shank Drills—*Addendum*

It has been pointed out by the J. C. Glenzer Company of Detroit, that it holds patents on three of the drivers illustrated under the above title (*AM*—Vol. 77, page 85). These drivers are shown in Figs. 1, 3 and 5, covered respectively by patents 1,304,473, 1,863,107 and 1,863,108.

Aging of Zinc Die-Casting Alloys—*Correction*

An error has been found in the Reference Book Sheet on the above title (*AM*—Vol. 77, page 213), concerning the time of stabilizing "Zamak" alloy No. 3. Aging treating No. 1, second column, should read as follows:

"1. Heat to 70 deg. C. for 10 hours, or to 85 deg. C. for 5 hours, or to 100 deg. C. for 3 hours. Follow any one treatment with furnace cooling over a period of at least 5 hours to room temperature."

Johnson Tried Chrome Plated Tools—*Discussion*

M. P. DALTON
Sevenoaks, Kent, England

The article under the above title (*AM*—Vol. 77, page 20) recalls several applications of electro plating which are not commonly known. Although nickel is not so hard as chromium, a coating of nickel can add life to many lightly-loaded cutting tools, especially where corrosion is to be expected. One reason why carbon steel tools fail quickly on some non-metallic materials is that the constituents attack the tool chemically, especially when heated by the cut. Nickel plating will prolong the life of tools on ebonite and certain types of casein products. An interesting application is in printing. The rotary printing plates for a cheap encyclopedia were nickel plated and gave five times the previous life.

Assembly Notes on Drawings

WILLIAM H. KELLOGG

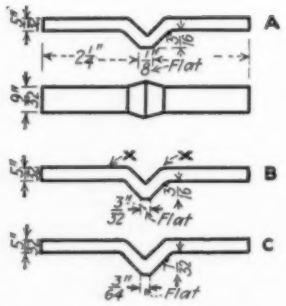
It is a convenience to both the shop man and the designer when having a detail drawing of a particular part of a machine, to have some kind of ready reference that will indicate the other parts that are to be assembled with the part in hand. This is particularly so when a large amount of work of considerable variety is being handled, often making it difficult to place in mind the exact relation of one part to another.

With this in view, the writer has found it expedient to make a note on the drawing of the detail to be made, calling attention to all of the detailed parts that are to be assembled directly with that particular part. The note may be placed in any convenient part of the drawing not otherwise occupied. It should begin with the words: ASSEMBLED WITH, and be followed by the detail numbers and the symbols of the parts referred to, preferably in numerical order. The names of the parts need not be placed in the note, as their numbers take less space and are sufficient as an aid to a search for any of the parts in question.

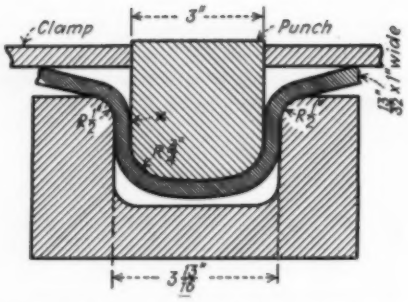
Supposing the letter *D* is a prefix to all part numbers of a particular machine or class of details, then the note would appear something like this: ASSEMBLED WITH *D*-10, *D*-11, *D*-14, *D*-95, and so forth.

Press Work Pressures

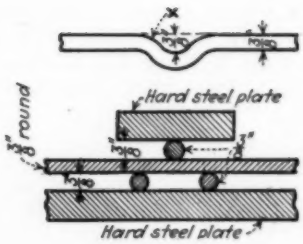
Series VI—*Forming*



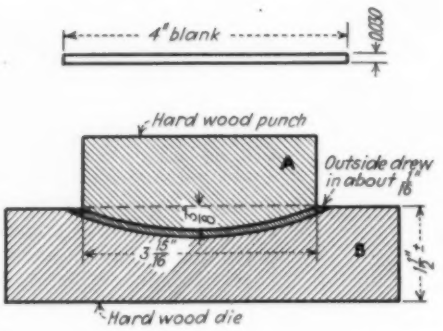
Material--Machine steel,
5/32 x 9/32 in.
Operation--Form cold
Pressure--Piece A -- 15,000 lb.
Piece B -- 38,000 lb.
Piece C -- 29,000 lb.
Piece B required extra pressure
to coin metal at x-x



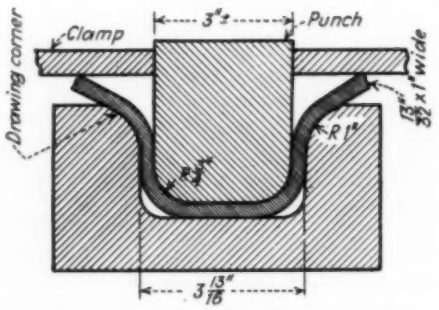
Material--0.50 to 0.55 carbon steel, 13/32 in.
thick by 1 in. wide
Operation--Formed cold
Pressure-- 26,400 lb. Metal broke at X



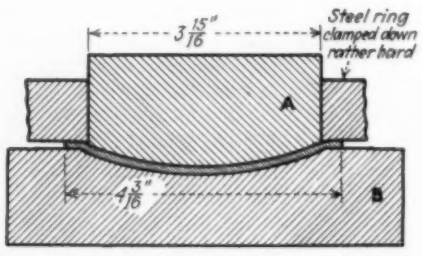
Material--A. Unannealed tool steel,
3/8 in. in diameter
B. Spring steel,
3/8 in. in diameter
Operation--Formed with temporary die
Pressure--A. 9,500 lb.
B. 22,500 lb.
Test made in testing machine



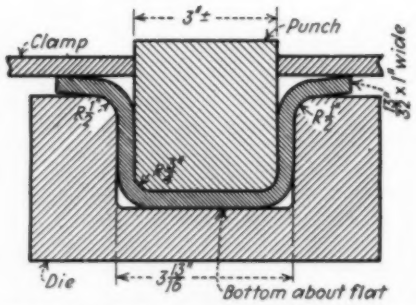
Material--Steel blank, 4 in. in diameter by
0.030 in. thick
Operation--Dished 3/8 in. deep
Pressure--16,000 lb. Some wrinkles still remained



Material--0.50 to 0.55 carbon steel, 13/32 in.
thick by 1 in. wide
Operation--Formed similar to other job above,
except that drawing corner was
made with a 1-in. radius to prevent
breaking the stock
Pressure--32,000 lb.



Material--Steel blank, 4-1/4 in. in diameter
by 0.030 in. thick
Operation--Dished 3/8 in. deep
Pressure--10,000 lb. Blank drew in 1/16 in. on
diameter



Material--Machine steel, 13/32 in. thick by
1 in. wide
Operation--Formed cold
Pressure--33,000 lb.

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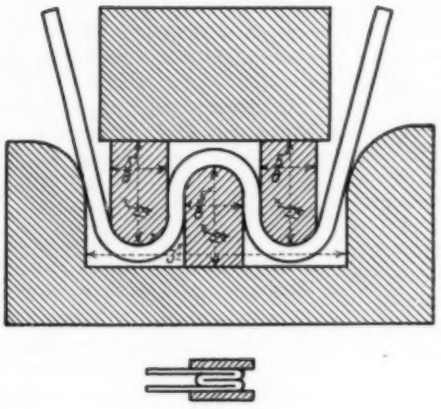
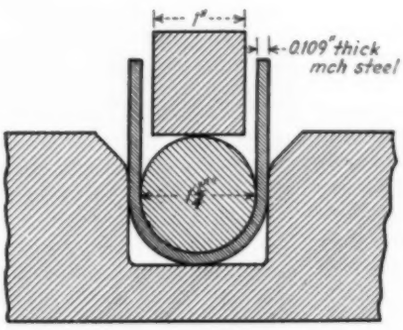
Press Work Pressures

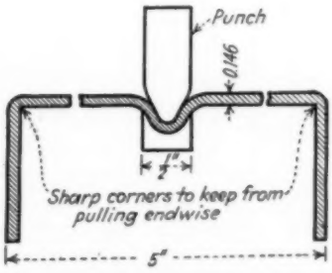
Series VI—*Forming*



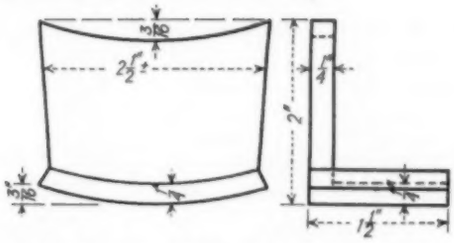
Material--Machine steel, 3/16 x 2 1/4 in.
Operation--Form cold
Pressure--10.5 tons
Formed piece mashed flat until no light showed between corrugations; Pressure required, 50 tons.



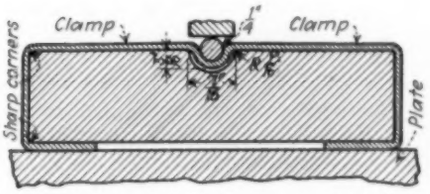
Material--Machine steel, 0.109 in. thick
Operation--Formed cold
Pressure--1-in. width-800 lb.
2-in. width-1,600 lb.
3-in. width-2,100 lb.



Material--Machine steel, 0.146 in. thick by 1-3/8 in. wide
Operation--Formed cold while stretching the metal
Pressure--10 tons



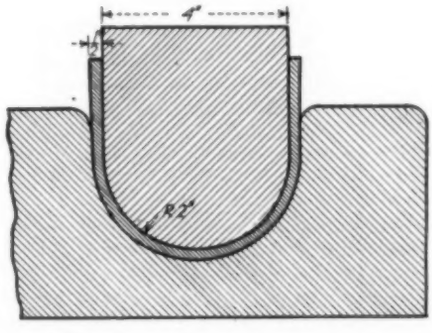
Material--Machine steel angle, 2 by 1-1/2 in.
Operation--Short leg of angle curved as shown
Pressure--30 tons



Material--Soft steel (thickness in table below)
Operation--Form groove (by stretching the metal)

Groove:Depth	Length	Thickness	Pressure
3/16in.	3in.	0.078in.	12 tons
1/4	3	0.078	12
15/64	4	0.05	8

Material--Soft steel, 0.0375 in. thick
Operation--Formed with bottom flat
Pressure--Strip 1-1/2 in. wide-2,000 lb.
Strip 3 in. wide-4,000 lb.
Strip 6 in. wide-8,000 lb.
To make bottom flat with minimum pressure, the dies should have a lower knockout with heavy up pressure. Otherwise, about three times the pressure will be required to flatten the bottom



Material--Machine steel, 1/2 in. thick by 1-1/2 in. wide
Operation--Formed cold
Pressure--12,000 lb.

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• IDEAS FROM PRACTICAL MEN

Mechanical Feeds for Press Tools

CHARLES F. KRAUT

The tools illustrated were designed for blanking and forming shallow covers, one of which is shown below. Since the walls of the covers are but $\frac{1}{32}$ in. thick and $\frac{3}{32}$ in. deep, the covers could not be made in tools of the combination type, because the combined blanking and forming punch would be too fragile.

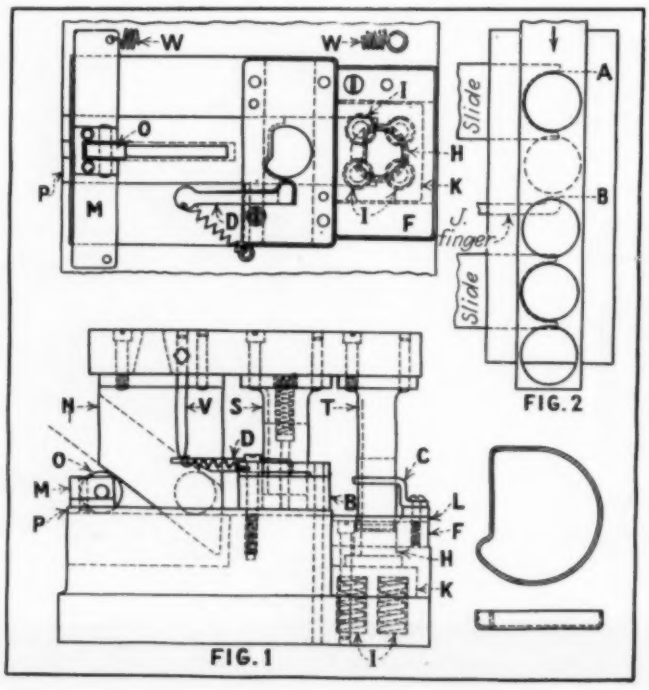
Referring to the illustration, the principal members of the tools can be identified by the following reference letters: *B*, blanking die; *C*, stripper; *D*, jump finger-stop; *F*, forming die; *H*, spring pad; *I*, compression springs; *K*, spring pad; *L*, nest; *M*, carriage; *N*, cam; *O*, cam roller; *P*, transfer slide; *S*, blanking punch; *T*, forming punch; and *V*, operating pin for the jump finger-stop.

The bolster has a clearance slot for the vertical moment of the cam, and also a shallow slot in its face for the operation of the carriage. The forming pad has a trademark engraved upon its face. All the parts comprising the forming die are mounted on the projecting part of the bolster, and the nest and the stripper are both attached to the forming die, being held in accurate location by dowel pins. At *W* is indicated the method of attaching one of the two springs for keeping the cam roller on the carriage in constant contact with the cam.

In operation, one end of the coil stock is pushed through the slot in the stripper and is advanced far enough to be attached to a scrap winder (not shown). As the ram descends, the first blank is produced and is pushed to the bottom of the die, where it is confined until the carriage is moved back by the cam, permitting the blank to be deposited by two spring-actuated plungers into the slot in which the carriage operates. As the ram ascends, the carriage transfers the blank and slides it into the nest.

As the ram again descends, another blank is produced, the carriage is forced to retreat and the blank is deposited in the slot, as before. Then the forming punch pushes the first blank into the forming die, and the shallow shell is formed. As the ram ascends, the pressure pad forces the formed shell out of the die and, as it clings to the punch, it is removed by contact with the stripper. It is then blown by a blast of compressed air into a funnel-mouthed chute that delivers it into a container. At each cycle of the press a finished cover is produced, and the press runs continuously until the entire coil of stock has been used.

A tandem layout for the blanking and forming of two shells complete in each cycle of the press is shown in Fig. 2. The tools are designed exactly like those in Fig. 1, except that they are wider to provide for the double layout. The arrow at *A* indicates the edge of the first blank, while the arrow at *B* shows the double distance advanced by the stock at each cycle. Tools designed like the ones described, obviously dispense with the usual second, independent forming operation, and are faster and more economical than are tools equipped with either magazine or dial feeds.



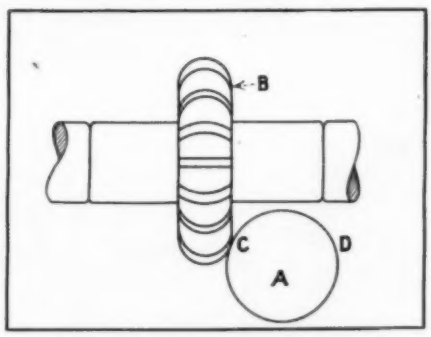
Combination type tools would have been too fragile for this job so the operations were laid out in tandem. Compressed air blows the finished piece through the chute into a container

Setting the Index Centers Central With a Formed Cutter

J. ARTHUR SPOHR

The following is a method I have successfully used in setting the index centers of a milling machine in a line central with a formed cutter of symmetrical shape.

With a cylindrical piece of finished work, as *A*, between the index centers, bring one side of the finished piece, as near the center as possible, into light contact with the edge of the cutter *B*, as at *C*, by raising the knee of the machine, noting the dial readings on the collars of both the elevating and the crossfeed screws. Before making the



A method of setting index centers in a central position, using a formed cutter on the side of the work

contact, the crossfeed screw should be turned to take up the slack in its nut in a direction away from the cutter.

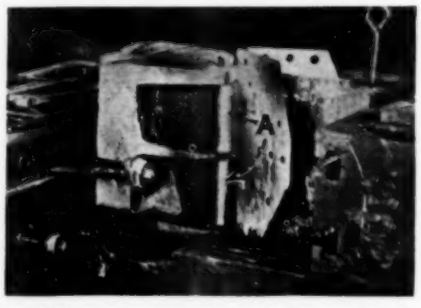
The knee is then lowered enough to permit the piece *A* to pass under the cutter, and the piece *A* is moved to the opposite side of the cutter. The knee is

raised to the same height as before and the opposite side of the piece *A* is brought into light contact with the edge of the cutter, as at *D*, by the crossfeed screw. Noting the reading of the dial on the collar of the crossfeed screw, the knee is again lowered enough to permit the piece *A* to pass under the cutter, and the crossfeed screw is turned to move the saddle half the distance traveled between the contact points *C* and *D*. The index centers are then in line with the center of the cutter.

Improving a Bulldozer Die

A. E. GRANVILLE

A car shop that makes a large quantity of heavy metal stampings, afterward bent to a U-shape, encountered considerable difficulty in bending them to the necessary U-shape in a bulldozer. In spite of the careful rounding and polishing of the edges of the die, the



Rollers, placed properly in a bulldozer die, prevent tearing and uneven stretching of the metal

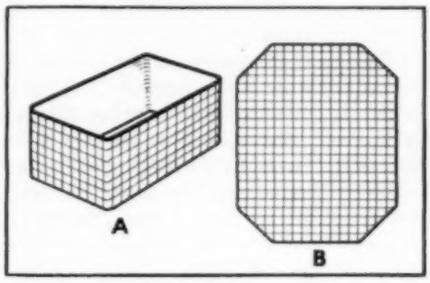
metal would stretch unevenly, and sometimes it would tear, as the punch forced it into the die.

The use of plenty of grease helped matters somewhat, but it made a very messy job and slowed up production. Finally, as an experiment, rollers, as at *A*, were placed at each edge of the die. Since applying the rollers, no lubricant has been necessary and there has been no tendency of the metal to tear or to stretch unevenly.

Finding the Size and Shape of Blanks for Irregular Shells *Discussion*

CHARLES KUGLER

In an article under the title given above (*AM*—Vol. 77, page 123), Charles Weslow says, "Many a diemaker is baffled in finding the correct size and shape of a blank for drawing a shell of irregular shape." I would like to add to this statement that it is not an easy matter to find the correct size and shape of a blank for drawing such a regular shape as the rectangular box at *A* in the illustration. Even though the mathematical method is used to find the size and shape of the blank, there will be trouble with the four corners. We know that a trial blank for this box will look something like the blank at *B*,



By scribing small squares on the trial blank, one can see just how the metal flows in changing shape. Corners usually give the most trouble

which is not drawn to the same scale as that of the box.

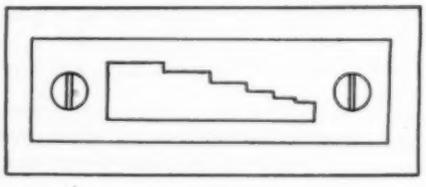
In one shop where I worked, it was the practice to scribe on the trial blank a series of lines forming small squares, as shown on the blank *B*, so that after the blank was drawn, just how much the metal stretched or crumpled could be told by inspecting or measuring the squares. The squares also gave a hint as to where metal must be added or removed. I know of one diemaker who makes a sample of the product direct from the blueprint, building it up in sections if necessary. He does not assemble the sections, but weighs them on a pair of druggists' scales. This gives him the weight of the trial blank. It also reduces the number of trials to begin with, because he has a blank of the correct weight. While it is true that the blank will stretch in the operation of drawing, nevertheless it is a great help in the right direction.

A Dog Tightener—*Discussion*

L. KASPER

The device described by Herbert M. Darling in an article under the title given above (*AM*—Vol. 77, page 187) is undoubtedly a time saver over using a wrench. However, by making the device as shown in the accompanying sketch, its value will be increased. Not only will it occupy less space than the device described by Mr. Darling, but its use eliminates the hunting for the correct hole to fit the head of the screw.

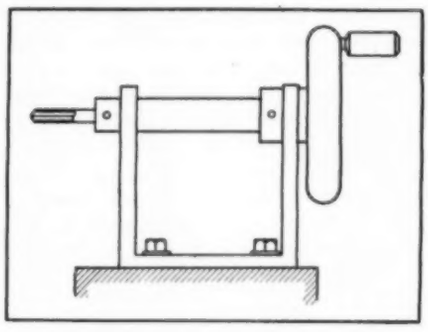
In use, the head of the screw is placed against the straight internal surface and is slid into the notch that fits it.



A Hand-Tapping Device

SAMUEL D. BRYDEN

Hand tapping and retapping small parts can easily be done by the device illustrated. The tap is held in the spindle, at the opposite end of which is a comparatively large handwheel having a



heavy rim. The spindle is mounted in the U-frame.

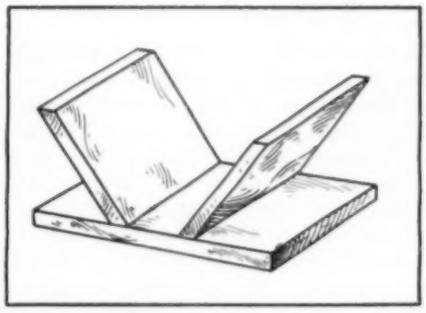
The work to be tapped or retapped is held in the left hand, while the handwheel is operated by the right hand to advance the tap into the work. Spinning the wheel in the reverse direction backs out the tap quickly.

Drafting Room Kinks

FORDYCE W. BROWN

To use up short pencils, we place them in the ordinary pencil holders, or nickel plated tubes. Since the holders are round and smooth they are always slipping in the fingers. We knurled them with a fine knurl and now they can be held with a much lighter grip than before without slipping.

We have several thousand tracings



An easily made holder for tracings and prints until they can be filed

9x6 in., and many of them are blueprinted each day. It is the duty of a clerk to give out the tracings when wanted and to file the ones that have been returned.

To facilitate the work of filing, we made a rack like the one illustrated. The tracings to be filed are sorted and piled on the table in numerical order. A bunch of the stored tracings is removed from its pigeon hole in the cabinet, depending upon whatever numbers are carried by those to be filed, and is then placed in the rack, resting against the inclined side at the right.

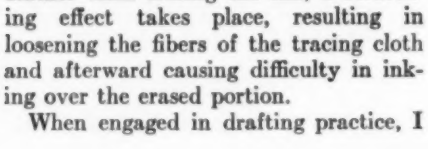
With his left hand, the clerk turns over the tracings as he would the leaves of a book, stopping when the number he wants has been reached. With his right hand he then lifts a tracing from the pile on the table and drops it into place among the tracings in the rack. This proceeding is continued until all the tracings on the table have been filed. The bunch of tracings is then taken out of the rack and is placed in the pigeon hole from which it was removed.

A New Use for Old Razor Blades—*Discussion*

ROBERT H. FORTMAN
Head, Mechanical Engineering Department, American School

Referring to the article by C. Cole under the title given above (*AM*—Vol. 77, page 188), I have tried various ways of erasing inked lines from tracing cloth, including the suggestions of Mr. Cole. Rather than erasing the ink, a scratching effect takes place, resulting in loosening the fibers of the tracing cloth and afterward causing difficulty in inking over the erased portion.

When engaged in drafting practice, I



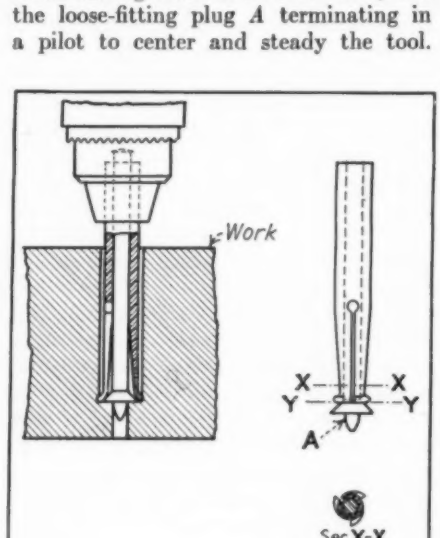
Hacksaw blades that have seen better days can be used by the draftsman instead of razor blades

included in my kit an ink eraser like the one illustrated. Such an eraser can be made from a piece of old hacksaw blade about four inches long. The arc *A* is ground to a sharp knife-edge and is later honed on a fine oilstone. In use, the arc *A* is in contact with the ink to be erased and the eraser is drawn over the tracing cloth very lightly, so as to remove most of the ink. Afterward, a pencil eraser is used, rubbing lightly so as to avoid heating and smearing the tracing cloth. Used in this way, all the ink can be removed without damaging the tracing cloth. Of all the many methods of erasing I have tried, I have found this one to be efficient.

A Recessing Tool for the Drill Press

EMIL WITTMANN

The tool illustrated is for cutting a recess at or near the bottom of a blind hole. It consists of a piece of tubular tool steel, hardened and slit in three places for part of its length, and having three cutting teeth at its lower end; and the loose-fitting plug *A* terminating in a pilot to center and steady the tool.



Small holes can be recessed, or undercut, by using this form of spring tool

Above the pilot is a tapered shoulder of a size that will freely enter the drilled hole. While the plug can slide up and down in the tool, it is prevented from falling out by being headed over on the upper end.

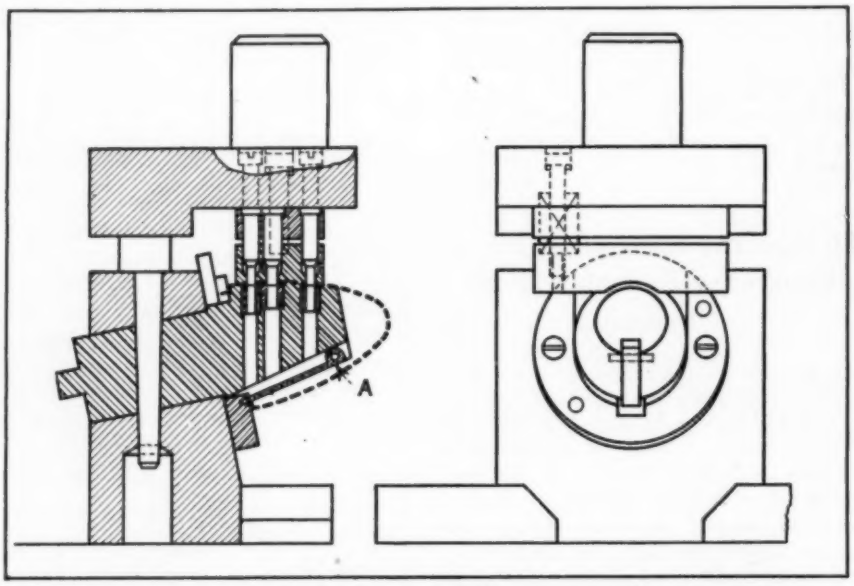
In operation, when the tool is lowered into the drilled hole as far as it will go, the pilot contacts with the conical bottom of the hole left by the drill, centering the tool. Continued downward movement forces the split end of the tool into contact with the taper on the shoulder of the plug, expanding the split part and causing the teeth to cut the recess. In the act of withdrawing the tool from the hole, the split end loses contact with the tapered shoulder of the plug and contracts, so that the teeth will clear the wall of the hole.

A Slug Trap for Press Tools

JOHN J. MCHENRY

We had to make a large quantity of shells of the shape shown in place in the tools in heavy dotted lines. After the shells were drawn, three holes in line of different sizes had to be pierced in one side near the end, the work being done in a horn press. We had trouble because the slugs fell into the shells and would stick there because of the lubricant used in drawing, and unless they were gotten rid of, they would cause trouble in a subsequent operation. The tools themselves have no unusual features, interest being centered on the means for trapping the slugs to prevent them from falling into the shells.

A channel, wide enough to admit freely the larger of the slugs, was milled in the under side of the horn, and the



Slugs punched out of shells gave trouble in succeeding operations until the method shown was devised for getting rid of them

swinging latch *A* was fitted to cover it. Normally, the latch hangs downward by its own weight, leaving the channel uncovered. When a shell is pushed onto the horn, it pushes the free end of the latch upward, closing the channel. As the punches pierce the shell, the slugs are trapped in the channel by the latch and are prevented from falling into the shell. When the shell is removed from the horn, the latch falls by its own weight and releases the slugs, which fall into a receptacle below the horn.

The slug trap is adapted to all tools of the horn type where the possible chute for slug release is less than 45 deg. If the chute can have an inclination of 45 deg. or over, the slug trap is not required.

Checking Internal Tapers

WM. C. DRONBERGER
Instructor Mechanical Arts
Cass Technical High School, Detroit, Mich.

Continuously following the numerous interesting articles in the *AM* for several years makes me feel guilty of being entertained without entertaining. Therefore, I am wondering if one of our high-school problems would be of interest. With the understanding that it pertains to a definite objective for a practical purpose, it is presented in the usual manner for use in connection with our machine-shop practice.

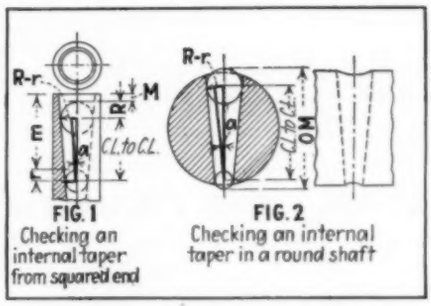
Problem: To determine the angle and the diameter of a taper hole, as in Fig. 1., by depth-micrometer measurement from a squared end to steel balls of a chosen diameter.

Procedure: Measure the approximate diameter near the large and the small ends of the taper; choose a steel ball for the large end that will lie slightly below the surface; and another ball for the small end that is sufficiently large to be supported entirely by the conical wall at the small end; record their diameters. Locate the small ball firmly in the small end of the tapered hole and obtain an axial measurement by depth micrometer from the squared surface to the top of the ball. Record this measurement as *m*. Insert the large ball and similarly record its measurement from the same surface, as *M*. Denote the axial cross-section angle by *a* (half of the included angle of taper) and the section of the right triangle formed by the radius of the large ball at the point of tangency by *R-r*. In trigonometric terms, the side adjacent to *a* is parallel with the side of the taper, and the center distance of the steel balls coincides with the axis of the taper; therefore, the angle with the center line may be computed by natural trigonometric functions. Tables of these functions can be found in the *AM Handbook*, 4th edition, page 853, or page 1015 in the 5th edition.

This angle is determined by evaluating the following formula:
Where *a* = one half the included angle of taper,
M = depth measurement to large ball,
m = depth measurement to small ball,
R = radius of large ball, and
r = radius of small ball.

In the right triangle in Fig. 1, the side adjacent to the angle equals the center distance of the two steel balls. This is obtained from the measurements by deducting *MR* from *mr* and the side opposite to the angle is equivalent *R-r*. Then sin *a* equals *R-r* divided by the center distance (in inches), and tan *a* represents one half the taper per in., or double this for the taper per inch.

The chord diameter at the tangent plane of the large ball is determined by the known ball diameter *D* and the angle *a* by evaluating cos *a* multiplied



How measurements are taken to check internal tapers

by *D*, and the axial distance of the chordal plane from the center of the ball equals the product of sin *a* and the radius *R* of the ball. The distance from the center of the large ball to the squared end is *M* + *R*, and by adding the chordal distance locates known chord diameter at a known distance from the reference plane. The taper per in. has been determined by former calculation. With this datum the diameter at the reference plane is obtained by multiplying the taper per in. by the total chordal distance in inches from the reference plane and adding the result to the chordal diameter.

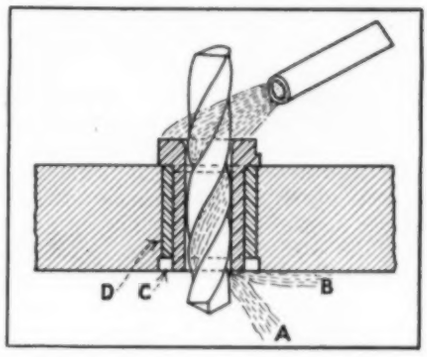
Computing the angle of taper by outside-micrometer measurement over projecting steel balls, as in Fig. 2., where *OM* represents the outside-micrometer measurement over the tips of the steel balls, with respective radii of *R* and *r*, the center to center distance is obtained by deducting the sum of the radii *(R + r)* from the outside measurement *(OM)*. Solve the corresponding right triangle, as in Fig. 1, for the angle of taper and its corresponding taper per inch.

Keeping a Drill Cooler

W. G. HOLMES

The method indicated in the illustration has been used to supply additional flooding of the drill by the coolant, or lubricant. The rotary motion of the drill imparts centrifugal force to the coolant as it is ejected from the bottom of the bushing, as at *A*. Through capillary attraction, the coolant has a tendency to run along the under side of the bushing plate, as at *B*. This action may be seen as one or more steady streams that continuously flow along the under surface of the bushing plate.

By counterboring a recess ⅛ in. deep and wide at the bottom of the bushing plate, as at *C*, the capillary action is broken, resulting in an increased cooling



Keeping a drill cool by checking capillary attraction under the jig

and lubricating of the drill. Where a liner bushing is used, as at *D*, it should be ⅛ in. shorter than the drill bushing, leaving a recess. Otherwise the recess must be made by counterboring. It is desirable to limit the distance between the drill and the recess to not more than ¼ in. to prevent side drainage, since a wider surface at this point helps to build up a strong flow of coolant under the bushing plate.

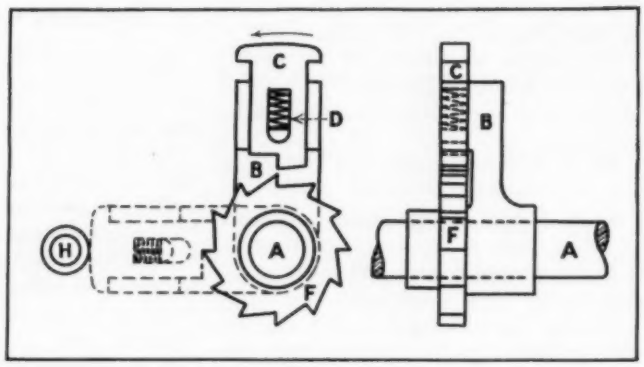
The use of this method has effected a 10 per cent saving in drills used on drop forgings in drilling holes of a depth of about three diameters.

Device for Producing Intermittent Rotary Movement

L. KASPER

A device for obtaining intermittent rotary motion from a constantly revolving shaft is shown in the illustration.

The shaft *A* carries the arm *B* and revolves in the direction of the arrow. Arm *B* carries the pawl *C*, which slides in a dovetailed seat, and is normally kept in its outer position by the spring *D*. The ratchet wheel *F* is free to turn on the shaft, and carries on its hub a



For the designer who wants to get a positive intermittent motion from a constant speed shaft

gear (not shown) for transmitting the intermittent motion to the receiving member of the system. On some stationary part of the device is mounted the roller *H* at the correct distance from the center of the shaft.

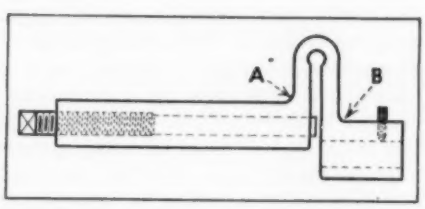
In operation, since the arm *B* is keyed to the shaft, it revolves with it, while the ratchet wheel remains stationary. As the outer end of the pawl contacts with the roller, the pawl is forced inward and into engagement with the ratchet wheel against pressure of the spring, as shown in the dotted lines. Thus the ratchet wheel rotates in unison with the shaft until the pawl passes by the roller, at which time it is disengaged from the ratchet wheel by the spring, permitting the ratchet wheel to remain stationary throughout the balance of the cycle. The number of degrees through which the ratchet wheel rotates at each cycle is controlled by the width of the pawl where it contacts with the roller.

An Improvement in Gooseneck Toolholders—*Discussion*

DONALD RAEBURN
Glasgow, Scotland

In an article under the title given above (*AM*—Vol. 77, page 92), Emil Wittman describes his method of preventing deflection of the tool by welding plates on each side of the spring bar. This device would be very satisfactory, provided the cutting edge of the tool had been placed in correct relation to the points of flexure. The tensioning screw is, in my opinion, also incorrectly and inconveniently placed, as it limits the size of the section of the toolbit used; a very important point in preventing deflection.

In the accompanying sketch is shown a toolholder of carbon steel, in which the cutting edge of the toolbit is placed in the correct position—below the points of flexure—as indicated at *A* and *B*, and a hole is drilled and tapped through the shank for the tensioning screw; a more convenient arrangement. With this design of gooseneck toolholder, threads of a comparatively coarse pitch can be roughed out and finished without deflection, provided the adjusting screw is correctly used.



Gooseneck tool with adjusting screw to prevent deflection

SEEN AND HEARD

JOHN R. GODFREY

Profit in Reading Advertisements

A reader suggests that it would be profitable for factory executives to read more carefully the advertisements in such journals as the *American Machinist*. For example: In the issue for September 8th a well known manufacturer of taps and dies suggests different kinds of taps for various kinds of work. A few days later a factory superintendent orders a supply of ¼-in. 20 H.S. taps for production use on small cast iron parts and unthinkingly furnishes some of the same lot of taps for use in the tool room. The grief resulting when Jones breaks one of those taps in a large (carbon) die steel, where the tap hole can not be re-located for want of space, may be better imagined than described.

One Operation or Two?

Anyone who has studied the way in which a good designer can take a few cams, gears, shaft and lever arms and make them into a machine that will punch, form, twist, cut off and do other stunts with a wire or a strip of sheet stock, eliminates the word "impossible" from his vocabulary. A designer who knows his stuff along this line can do things that are almost uncanny—and things that it doesn't pay to do at all in some cases. Possibility and economy don't always go together. Almost any operation can be done by machine but it is frequently cheaper to do it by hand—because of other things than the operation itself. A case in point is a special wire pin with a guard, which is put on at a separate operation. It would not be hard to make them both at once and assemble them. But the guard must be tumbled for hours to get the right finish. If the whole pin were tumbled the points would be dulled and they would come out a tangled mass that must be separated. So it is cheaper to make each part separately and assemble at a second operation.

How Much Coolant?

It is a far cry from the can with water dribbling on a grinding wheel to the stream of fire hose proportions, that we now use on manufacturing grinders. "I know we need a lot of water," says the grinder, "but how much is a lot?" One of my grinding expert friends specifies two gallons a minute for each actual horsepower used by the machine. If, for example, the grinder has a 15-hp. motor but frequently goes to 20 hp. as a peak load, he insists on 40 gals. per minute. Use the horsepower as a base lest you forget the width of wheel. Then, too, we must provide water enough in the tank to allow some cooling before it is pumped back on to the wheel. He uses tanks holding from 2 to 2½ times the flow per minute for fairly continuous work, or 1½ when the work is intermittent. This gives an 80- to 100-gal. tank in the first case, and 60 gals. for intermittent grinding.

Marking on Steel

A reader writes:

"Every once in a while our shop turns up some new kink, or idea, that we think is brand new and clever. Then just about the time we begin to brag about it we find that everybody else has known it a long time, and that it isn't nearly so new as we thought. Right now we are wondering if anyone else has discovered, as we have just done, that a china marking pencil is a mighty handy thing to have around a lathe or bench. These pencils are intended by the makers for marking on china and glassware, just about as well as a regular pencil on ordinary paper. They will also mark just as readily and distinctly on almost any polished surface, such as steel, brass or nickel. They make a sharp line that is very distinct, they do not injure the surface and the mark does not come off too easily."

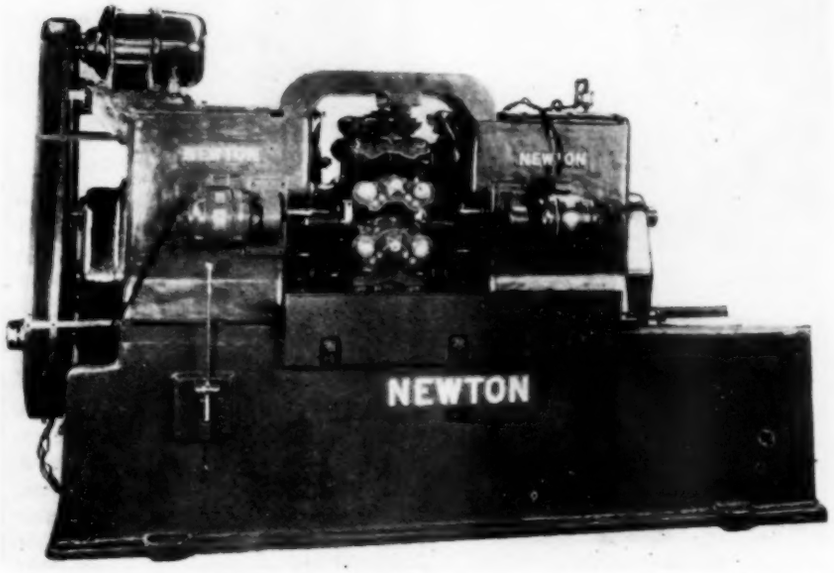
SHOP EQUIPMENT NEWS

Newton Drum-Type Milling and Center Drilling Machine

The Consolidated Machine Tool Corp. of America, Newton Division, Rochester, N. Y., is now offering a drum-type milling and center drilling machine for rapid production of cast brackets and similar castings required to be faced and center drilled on both ends, pump shafts, propeller shafts or other work of a similar nature. The machine illustrated has capacity for rough and finish milling both ends and center drilling work from 6 to 30 in. in length, but other machines for handling up to 72 in. can be furnished.

As shown, the machine was built for one of the light car manufacturers for facing and center drilling oil pump brackets, but while it was designed specifically for these short brackets it can be modified to take work up to 30 in. long. The top bracket carries arrangements for loosening the clamps on the drum. When the adjustable head is moved on the housing to accommodate longer shafts, a different type drum with the proper fixtures is substituted, and a top bracket suitable for the width between the heads takes the place of the one shown.

The machine is continuous in operation and requires only unloading and loading by the operator at one station. Clamps holding the work in place on the drum are tightened automatically as the drum revolves. After the work passes the cutters and center drills, the clamps are loosened automatically. Six spindles are regularly supplied, consisting of two roughing and two finishing spindles for milling and two auxiliary spindles for drilling. Chips are disposed of by gravity feed. Anti-friction bearings and centralized lubrication are provided. Production, based on the proper feed rate for the material and taking into consideration the diameter of the cut circle, will often range to as high as 300 to 400 pieces per hour. Three motors are required to drive the machine, the main drive motor at the top and two auxiliary drill spindle motors.



Castings, pump shafts and propeller shafts requiring facing on the ends and center drilling can be handled on this Newton drum-type machine

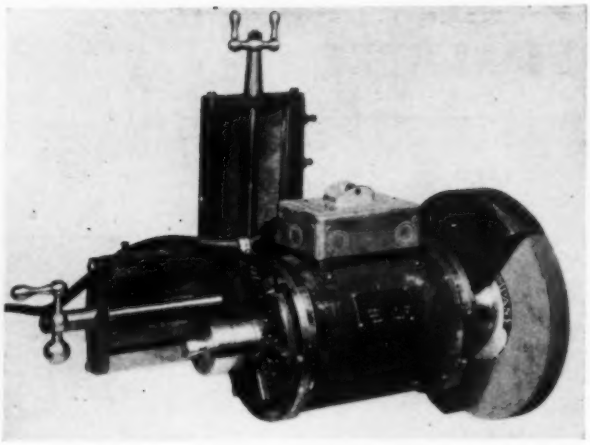
General Electric Small Circuit Breakers

A line of small circuit breakers, rated up to 600 volts and 600 amperes, and designed for the control and protection of industrial circuits, has been announced by the General Electric Co., Schenectady, N. Y. Designated as Type AF-1, these breakers offer speedy restoration of service, tamper-proof protection and quiet operation. Interruption of the arc takes place within a closed metal chamber, and the arc generates a pressure which increases the resistance of the arc path so rapidly that the circuit is interrupted in 0.008 second.

The breakers are trip-free from the operating handle and cannot be held in the closed position when overload exists. The appearance of the target indicates that the breaker has tripped. Breaker parts are inclosed in a housing of Textolite. Provision is made for convenient mounting in panelboards, dead-front distribution boards or individual metal inclosures.

"Standard" Angle Plate Grinder

Special roll or parallel grinding can be done with the angle plate grinder developed by the Standard Electrical Tool Co., Cincinnati, Ohio. Illustrated is a 2-hp. outfit which is fitted with a horizontal feed of 11 in., and a vertical feed of 6 in. Longer or shorter feeds, or one feed only can be furnished. The ma-



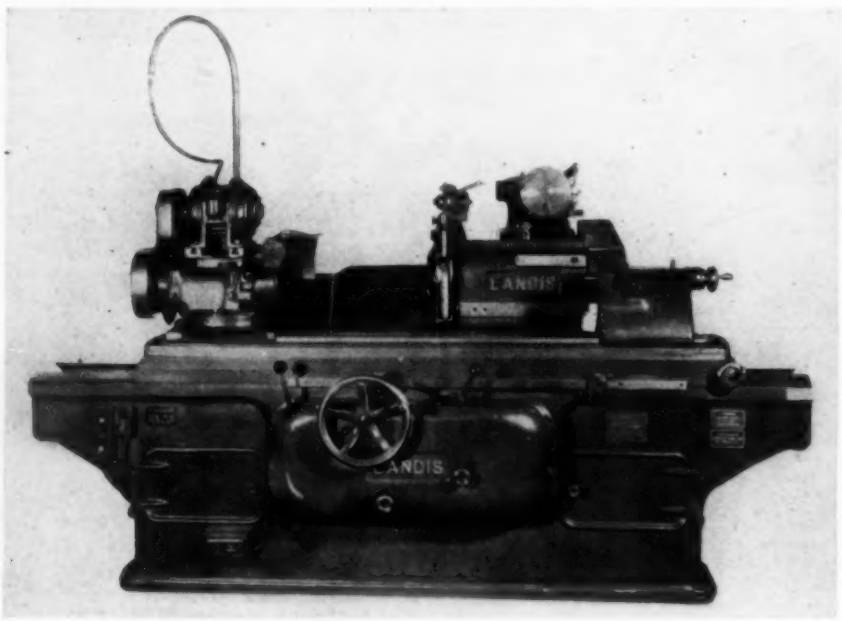
The "Standard" Angle Plate Grinder can be adapted for use on a lathe, planer, or boring mill, on a milling machine for grinding large cutters, and on a shear for grinding shear blades in place

chine weighs 193 lb., and carries a 12x1¼ in. face grinding wheel. Rotating parts are balanced to eliminate vibration. The grinder is adapted for use on a lathe, planer, or boring mill, on a milling machine for grinding large milling cutters, and also for grinding large shear blades in place without removing them from the machine. Sizes built are ½, 1, 2, and 3 hp. The switch is located on the motor housing. Armature shaft is made of nickel steel.

Landis Type C 14-In. Hydraulic Universal Grinder

A full universal grinder for manufacturing operations has been developed by the Landis Tool Co., Waynesboro, Pa. This Type C, 14-in. machine is made in three lengths, 36, 48 and 72 in. The headstock is fully universal, and it may be swiveled to 90 deg. for face grinding. The wheelbase is also universal and may be swiveled 90 deg. either side of center. It is equipped with a sub-slide so that the head can be moved forward or backward as the nature of the work requires. Standard equipment includes such universal features as an anti-friction internal grinding fixture, a chuck for internal and face grinding, an automatic hydraulic wheel feed mechanism, a center rest, and stationary and traveling cutter tooth rests. Special equipment such as rotary magnetic chucks and loose cam grinding heads may be supplied.

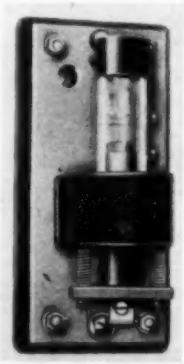
Accessibility is afforded to the various mechanisms for adjustment, inspection or repair. Removal of the large cover at the front of the bed exposes all control mechanisms and pipe connections. None of them is entirely within the bed. The large wheel spindle is driven at the end by a multiple V-belt. Babbitt-lined steel-back bearings are employed, lubrication of the bearings being by means of filtered oil from an oil pump driven by the spindle itself. A Landis feature is the double-cylinder, hydraulic table traversing mechanism which provides an almost infinite number of table speeds. With the multi-speed headstock and the table traverse, the operator can select a combination of work and table speeds suited to the particular part being ground.



Over-size construction at vital points fits the Landis Type C 14-in. Universal Grinder to production work

"Mercrelay" Mercury Switches

Both normally open or normally closed types of the "Mercrelay" mercury-type circuit controller are now available from the General Wire & Switch Co., 140 Benedict St., Providence, R. I. The relay employs a fused quartz cup at the point where the arc occurs. The device consists of a heavy glass tube containing mercury, entering electrodes, the quartz cup mentioned and a displacement member. The electrode at the bottom makes contact with the main body of mercury in the tube. The top electrode passes down through the tube and has secured at its end a fused quartz cup. This cup is partially immersed in the main pool of mercury. Floating on the mercury is a tubular member of magnetic susceptibility. The glass tube is placed within an electrical coil in such a manner that when the coil is energized the displacement member is drawn down by magnetic action, thereby raising the level of mercury. This results in the merging of the main mercury pool with that in the quartz cup, causing a completion of the electrical circuit. When the coil is de-energized the displacement member returns to its floating position and the original level of the mercury is restored.

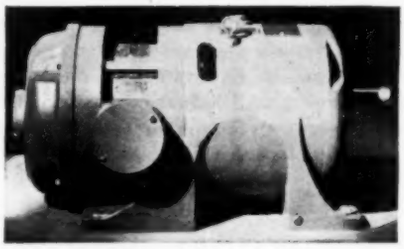


A quartz cup in the "Mercrelay" Mercury Switch resists the arc when the coil is de-energized

The resultant arc occurs around the edge of the quartz cup which is highly resistant to temperatures encountered in this service. Maximum rating, intermittent or continuous non-inductive load, is 25 amp., at 220 volts, a.c. or d.c. Coil current is 9 watts.

Reliance Type S Gearmotors

Type S gearmotors rated ¾ hp. and up are now available from The Reliance Electric & Engineering Co., 1042 Ivanhoe Rd., Cleveland, Ohio. The cartridge-type gear unit contains all gears and bearings except the high-speed pinion and bearing. This cartridge can be removed without disturbing the alignment of gears or bearings. The ratio

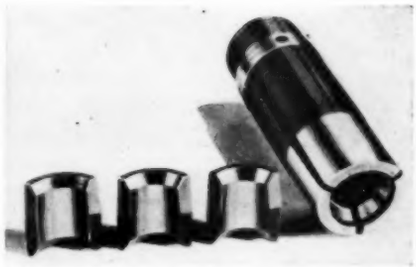


can be changed by the user by simply changing the high-speed pinion and gear. Rotating the cartridge gear unit provides from four to eight positions of the output shaft. Heavy feet cast integral with the gear housing are in a position to afford solid support, and the holding-down bolts at the driving end are close to the point of load application. Gearmotors can be supplied for a wide range of ratios with both a.c. and d.c. motors of various types.

Sutton Style "L" Master Feed Finger and Pads for Automatic Screw Machines

Interchangeable and replaceable pads are found in the Style "L" feed finger for automatic screw machines, now offered by the Sutton Tool Co., Curtis Bldg., 2842 W. Grand Blvd., Detroit, Mich. One master and different sets of pads will handle practically the full range of one machine. Pads are also interchangeable on different makes of machines of the same machine size.

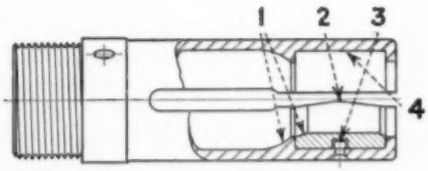
As shown in the accompanying drawing, the pads that grip the work are seated in a recess (4) in the master. The shoulder at either end of the recess holds the pads and takes the operating thrust. A pin (3) on the inside of the master engages a blind hole in one of



Sutton Style "L" Master Feed Finger with a set of three interchangeable and replaceable pads

the pads to prevent the pads from rotating.

The long taper (1) at the rear end of the pad brings the extreme end of the pad flush with the inside diameter of the master. The forward end of the taper is up to stock diameter. This



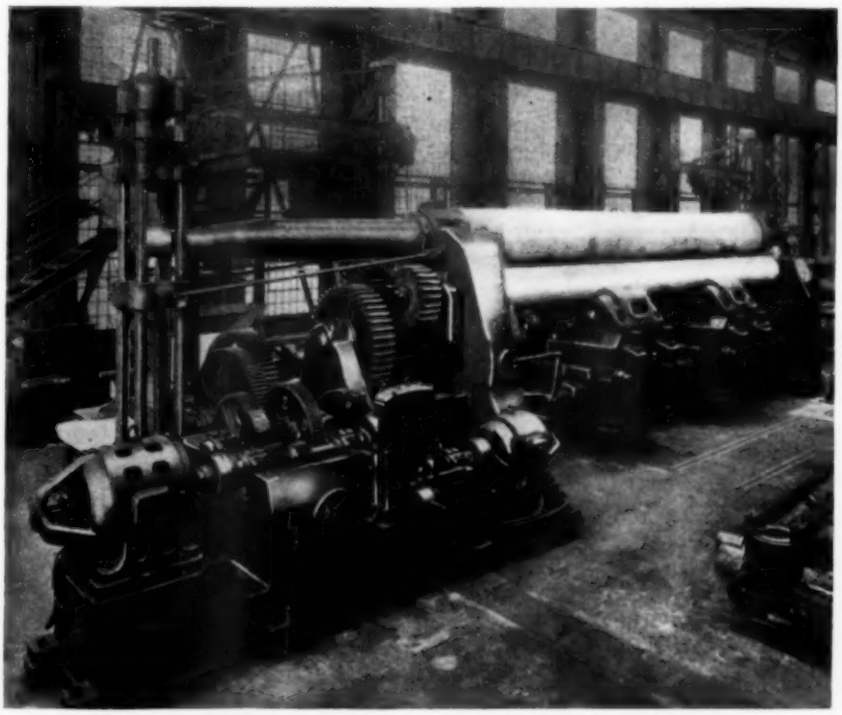
Cross-section of Sutton Style "L" Master Feed Finger, showing pads seated in recess

construction prevents jamming of the stock against the ends of the pad when the machine is being replenished. Each pad is also made with a double angle (2) on each side. When service has increased the hole size of the pads, the size can be restored by grinding down the points of the angles, allowing the tension of the master to bring the pads together. Pads can be furnished for handling round, hexagon or square stock.

Wagner Plate Bending Roll

Plates up to 28 ft. long and up to 1¾ in. thick, and having a tensile strength of 70,000 lb. per sq.in., can be handled on the Wagner bending roll of the 3-roll type. This machine was recently constructed by Wagner & Co., Dortmund, Germany, represented in this country by Marburg Bros., Inc., 90 West St., New York, N. Y. The minimum diameter to which the plate can be bent on this machine is 41 in. The top roll is 34½ in. in diameter and weighs 55 tons, while the lower rolls are 23⅝ in. in diameter, each weighing 23 tons.

The illustration shows the housing covers of the gearbox removed and also shows the drive of the rolls and the device for tilting the upper roll for the purpose of removing the plate endwise after it has been bent. The top roll is 28 ft. long and is crowned so as to give

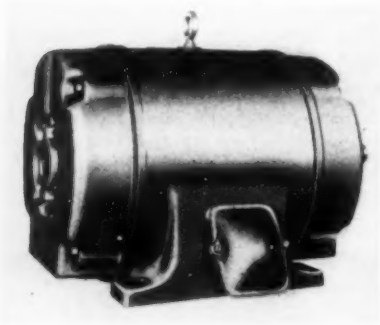


Rear view of the Wagner 3-Roll Bending Machine for handling plates up to 28 ft. long by 1¾ in. thick. At the left is shown the device for tilting the upper roll so that the plate can be removed

it greater resistance against bending. The two lower rolls are cylindrical and are provided with two intermediate-type reinforcing supports. A 170-hp. reversible motor provides power for driving the rolls, a 110-hp. motor tilts the upper roll, and a 6-hp. motor operates the device which disengages the outer bearing from the upper roll. All necessary operations are controlled from a raised platform adjacent to the driven end of the rolls. A dial on the platform indicates the setting of the upper roll. For the initial bending of the edges of the plates before placing them between the bending rolls, a 385-ton hydraulic press is used.

Century Splash Proof Motor

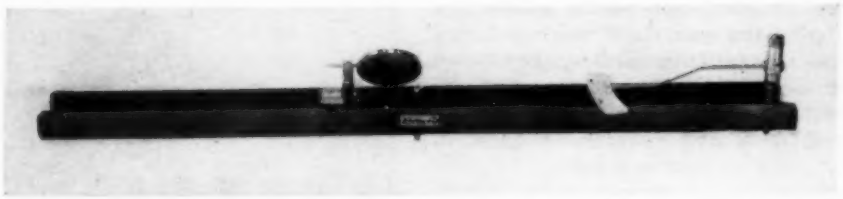
Splash-proof motors from 1 to 30 hp. have been added to its line by the Century Electric Co., St. Louis, Mo. The frame and end brackets of these motors are made of refined grey iron castings. One-way ventilation is provided by intake and outlet openings in the lower section of the end brackets. The bearing bracket is fitted to the frame by a long-contact sealed fit. Cartridge-type, grease-lubricated ball bearings are used on all sizes of motors.



Van Keuren Flatness Measuring Instrument

The Van Keuren Co., Watertown, Mass., has developed a flatness measuring instrument claimed to give the same precision in measuring machined, ground, scraped or dull-lapped surfaces as that obtained with an optical flat on highly finished steel surfaces. This instrument consists of a channel which supports a cylindrical line contact at one end, a micrometer at the other end, and a sensitive light wave indicator in the center. Means are provided for changing the positions of all three measuring contacts to permit measuring different surfaces, such as ring shaped laps, surface plates, and machine ways. Auxiliary flat contacts are provided for measuring machined or scraped surfaces in order to avoid measuring local hollow spots.

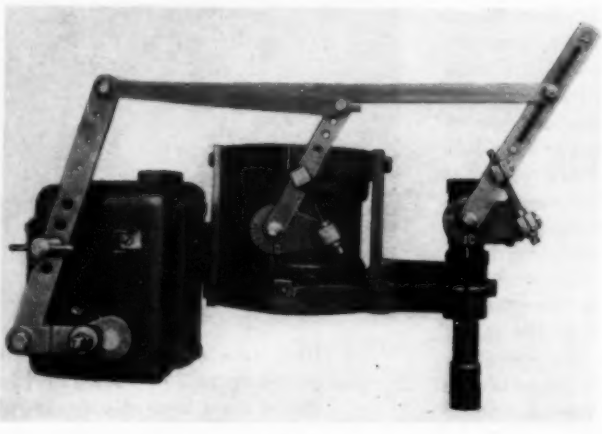
In use, the micrometer end of the instrument is lowered on the surface being tested until a slight movement of the interference bands on the indicator shows contact of the center point. The micrometer then shows the amount that the surface is convex or concave, after a zero reading has been taken on a master flat surface.



Van Keuren Flatness Measurement Instrument for machined, ground or dull lapped surfaces

A. T. C. Type 2 Motor-Operated Controller

The Automatic Temperature Control Co., Inc., 34 E. Logan St., Philadelphia, Pa., has added to its line a Type 2 motor-operated controller of the two-position type to operate one or more valves as a unit. The controller has sufficient power to handle an air valve up to 4 in. and a ½ in. fuel oil valve or to handle two valves up to 4 in. pipe size as a unit on low-pressure gas and air. Where furnace atmosphere is important, valves having similar characteristics are provided, each equipped with a micrometer screw adjustment for minimum setting, and with an index and dial plate to permit duplicating previous settings. With the valves adjusted for desired combustion, the fuel-air ratio is maintained throughout the controller stroke. Both valves are moved simultaneously and in unison by a linkage.



A.T.C. Type 2 Motor-Operated Controller with four-position fulcrum as mounted with an air valve, center, and a fuel valve, right

"E. C. M." Type A Safety Switch

The Electric Controller & Mfg. Co., 2696 E. 79th St., Cleveland, Ohio, has designed a line of compact safety switches in which nothing projects beyond the width of the box and in which the cover swings vertically. Features included comprise: semi-floating, double-break V-blades; V-type stationary contacts backed up with steel springs, individual barriers of arc resisting asbestos, all mounted on a single base which can be easily removed by taking out four screws. All actuating parts of the mechanism are casehardened. Dimen-

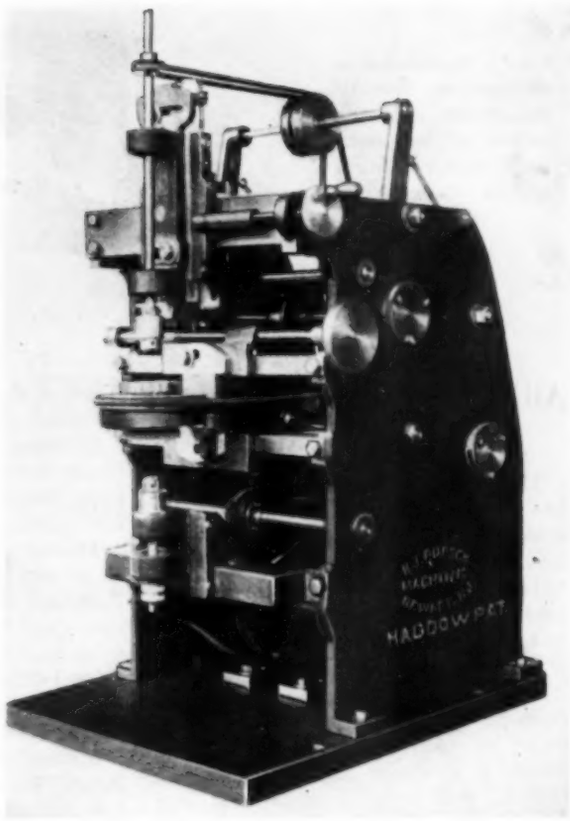
sions of the 60-amp., 3 pole, 230-volt, fusible safety switch are 9 in. wide by 17½ in. long by 4 in. deep.

Ruesch Cutting and Polishing Machine for Carbide Wire-Drawing Dies

The H. J. Ruesch Machine Co., 401-411 Mulberry St., Newark, N. J., has developed a machine under the Haddow patents for cutting and polishing cemented-carbide, wire-drawing dies. The machine will make a finished die from an incased rough nib, whereas the present general practice is to use two or three machines and polish by hand. It is said that the machine will perform all the necessary operations and eliminate all hand work.

The vertically reciprocating spindle which can be swiveled to obtain a maximum included angle of 45 deg. in the die, holds the straight wire or tapered rod. A revolving split collect, which can be swiveled, holds the die while being cut. The approach angle, the reduction area, and the bearing are cut at one setting of the die in the chuck to assure concentricity of all diameters. Except in the case of small diameter dies, the relief angle also is cut in the same setting. All of the angles and the bearing can be cut with a straight rod or wire except in the case of very small dies, where a tapered rod is advantageous. When a tapered rod is used for cutting the various angles, one tapered rod will cut any desired angle in the die up to 45 deg. Since the revolving and oscillating tapered rod is in constant contact with the surface being cut, grooves are impossible. Final polishing and rounding of edges of the die angle junctions is accomplished with a charged flexible wire held firmly in the upper and lower spindles. A split collet for a 2-in. diameter casing is furnished.

Dimensions: Width, 16 in.; depth, 21 in.; height, 30 in.; net weight, 210 lb.

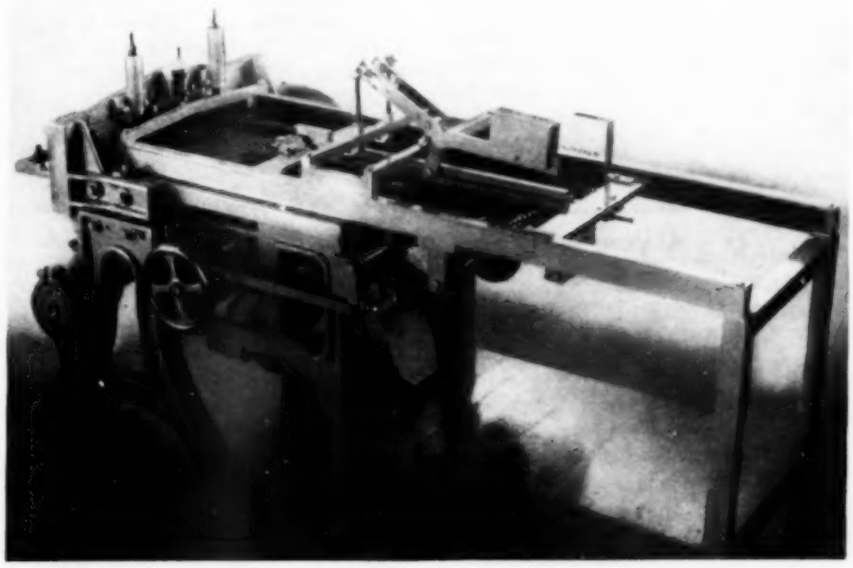


All cutting operations and the polishing operation required on cemented-carbide, wire-drawing dies are performed on this Ruesch machine

Brown Automatic Blanking Shear

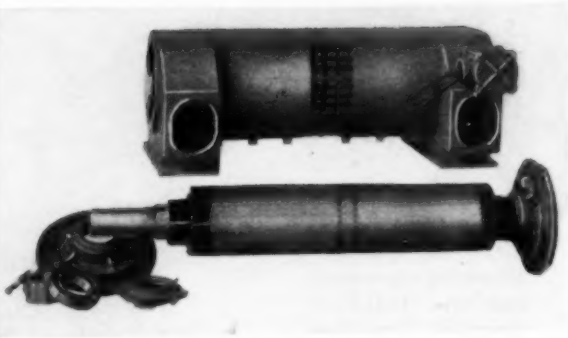
For blanking hacksaw blades and similar articles, R. H. Brown & Co., New Haven, Conn., has developed an automatic blanking machine. It is belt-driven as illustrated, but can be motor-driven if so desired. Stock ranging from 0.010 in. to 0.031 in. thick and from 8 to 15 in. wide by 24 in. long, can be handled. The machine will hold 200 sheets of 0.025 in. thickness at one setting. Sheets are loaded by hand and are automatically fed to jaws which carry them through the blanking operation. Speed of the machine is 110 to 120 r.p.m. The carriage returns and automatically picks up another sheet, all scrap being removed automatically from the machine.

All cams and clutches in the machine are made of steel, hardened and ground, and the carriage is ball-bearing equipped. Thrust bearings are provided in the table. All parts likely to wear are hardened and ground. The table has an adjustable feed and also can be adjusted to different sizes of stock. The gage at the shears can also be adjusted to the different widths of blanks required.



Operating at a speed of 110 to 120 strokes per minute, the Brown Automatic Blanking Shear is suitable for blanking hacksaw blades and similar articles

Like a dachshund in appearance, this Allis motor has the power of an ordinary motor several times larger in diameter



Allis Small-Diameter High-Powered Motor

The Louis Allis Co., Milwaukee, Wis., has developed a small-diameter, high-powered motor for such uses as direct-mounted grinding wheels, saws, and cutterheads, where the diameter must be held to a minimum. For example, the motor illustrated is rated at 100 hp., but is less than 12 in. in diameter.

This motor can be had in ratings from 30 to 100 hp. Ratings from 30 to 60 hp. can be furnished in a frame which is arranged for self-ventilation; that is, with a fan built integral with the motor. Ratings from 75 to 100 hp. require a separate blower unit. These motors are generally mounted in an inverted position, and to accommodate a minimum wheel diameter it is important that the motor has a minimum radius between the center of the shaft and the top of the stator. The top of the motor is flat, and the distance between this flat surface and the center of the shaft is 5 9/16 in. on all the above ratings. The diameter is between 12 and 14 in. Of course, the length varies according to the horsepower rating. In the case of the 100-hp. motor illustrated, the length is approximately 40 in. over the bearing chambers.

These motors are rated at a speed of 1,800 r.p.m., 60 cycles, and can be wound for 220, 440 or 550 volts.

• PATENTS •

APRIL 25, 1933

Metal-Working Machinery

Hydraulic Feed System for Machine Tools. Eric J. Hirvonen, Worcester, Mass., assigned to Leland-Gifford Co. Patent 1,905,094.

Hydraulically Operated Grinding Machine. Albert G. Belden and Herbert A. Silven, Worcester, Mass., assigned to Norton Co. Patent 1,905,127.

Metal Working Machine. George F. Yager, Toledo, Ohio, assigned to The Bunting Brass & Bronze Co. Patent 1,905,203.

Grinding Machinery. Frederick S. Haas and Clement Booth, Cincinnati, Ohio, assigned to Cincinnati Grinders Incorporated. Patent 1,905,224.

Method of and Machine for Hobbing Gears and the Like. John B. Sinderson, Rockford, Ill., assigned to Barber-Colman Co. Patent 1,905,310.

Method of and Machine for Hobbing Gear Teeth. John B. Sinderson, Rockford, Ill., assigned to Barber-Colman Co. Patent 1,905,311.

Milling or Cutting Machine. Oscar Hoppe, Rorschach, Switzerland. Patent 1,905,382.

Automatic Throw-Out Mechanism for Gear Cutting Machines. Eyvind Finsen, Rochester, N. Y., assigned to Gleason Works. Patent 1,905,456.

Broaching Machine. George J. Russell, Waltham, Mass. Patent 1,905,506.

External Broaching Machine. George J. Russell, Waltham, Mass. Patent 1,905,507.

Broach Centering Apparatus. George J. Russell, Waltham, Mass., Patent 1,905,508.

Broaching Guide. George J. Russell, Waltham, Mass. Patent 1,905,509.

Forging Machine. William L. Clouse, Tiffin, Ohio, assigned to The National Machinery Co. Patent 1,905,620.

Milling Machine. Walter D. Archea, Cincinnati, Ohio, assigned to The Cincinnati Milling Machine Co. Patent 1,905,673.

Machine for Honing and Polishing Crank Shafts. Walter F. Egger, Cleveland, and Logan A. Becker, Lakewood, Ohio, assigned to Norton Co. Patent 1,905,825.

Tools and Attachments

Control for Hydraulic Feeding Mechanism. Benjamin S. T. Bishop, Shrewsbury, and Eric J. Hirvonen, Worcester, Mass., assigned to Leland-Gifford Co. Patent 1,905,132.

Hydraulic Feed for Machinery. Benjamin S. T. Bishop, Shrewsbury, and Eric J. Hirvonen, Worcester, Mass., assigned to Leland-Gifford Co. Patent 1,905,133.

Safety Device for Grinders. Clifford T. Raule, Brookline, Pa. Patent 1,905,651.

Screw Thread Gauge. James Hartness, Springfield, Vt. Patent 1,905,705.

Collapsible Tap. Raymond L. Herman, New York, N. Y., assigned to Benjamin May and Louis Schulman. Patent 1,905,709.

Rolling Turner. James H. Richardson, Indianapolis, Ind. Patent 1,906,100.

Processes

Method of Making Spline Couplings. Otto F. Ewert, Genoa City, Wis. Patent 1,905,277.

Method of Making Spline Couplings. John Edgar, Rockford, Ill., assigned to Barber-Colman Co. Patent 1,905,278.

• TRADE PUBLICATIONS •

COATED ABRASIVE PRODUCTS. Simplified Practice Recommendation R89-32, superseding R89-28, has been published by the United States Department of Commerce, Bureau of Standards. Copies are for sale by the Superintendent of Documents, Washington, D. C., for $0.05 each.

MOTORS. Splash-proof motors, recently announced by the Century Electric Co., 1806 Pine St., St. Louis, Mo., are described in a folder which shows the construction.

PHOTOMICROGRAPHY. The Bausch & Lomb Optical Co., Rochester, N. Y., is distributing a circular on the use of short-focus "Micro-Tessars" lenses designed especially for low-power photomicrography. Examples of use are the photographing of the cross-section of a bore and the photographing of the surfaces of various materials.

ROLLER BEARINGS. "Engineering Data for Bantam Roller Bearings Using Small Diameter Rollers," published by the Bantam Ball Bearing Co., South Bend, Ind., provides additional information on small diameter rollers used without cages for bearings. The bulletin gives the formulas for calculating these bearings, shows the types of ends on the rollers, and provides a chart showing the load capacity at various speeds. A feature is the large group of illustrations on recent applications.

WELDING RODS. The American Manganese Steel Co., 389 E. 14th St., Chicago Heights, Ill., has issued a folder describing the properties and uses of "Amsco" nickel manganese steel welding rod and No. 459 hard surfacing welding rods.